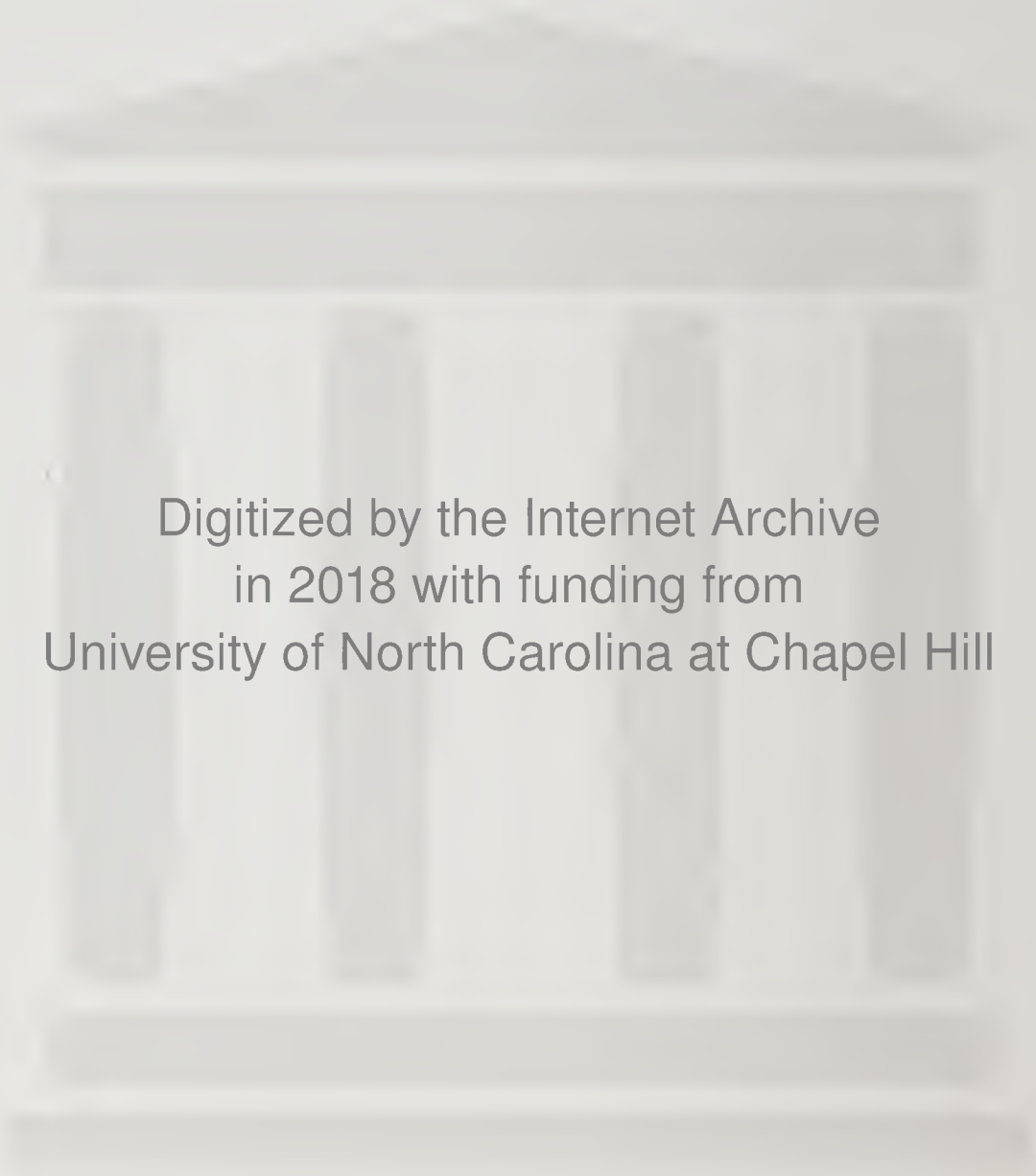
THE FIVE WINDOWS OF THE SOUL



THOUGHTS ON PERCEIVING

MEANWHILE the incipient Diogenes, like others, all ignorant of his Why, his How, or Whereabout, was opening his eyes to the kind Light, sprawling out his ten fingers and toes, listening, tasting, feeling, by all his five senses, still more by his sixth Sense of Hunger, and a whole infinitude of inward, spiritual, half-awakened Senses, endeavouring daily to acquire for himself some knowledge of this strange Universe where he had arrived, be his task therein what it might.—*Sartor Resartus.*

THE FIVE WINDOWS OF THE SOUL

OR

THOUGHTS ON PERCEIVING

BY

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AND 'A NATURALIST ON THE PROWL'

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PREFACE

I HAVE always held the opinion that the best preface to a book was none. Why should not a book be left to tell its own story, without a letter of introduction? I am told, however, that I must write a preface to this nondescript little volume, and I see the necessity. It arises from the fact that I have not been able to devise a title which will offer readers even a general idea of the subject to which their attention is invited. Perhaps the best way to do this will be to give an account of the genesis of the book.

About fifteen years ago a young friend, with whom I was conversing discursively *de rerum naturâ*, dropped the remark that beauty might be defined in terms of motion. This set me thinking on the *fact* that underlies our perceptions of beauty and grace, and thence my mind wandered

to the perception of melody and harmony in music, and so to other perceptions, both higher and lower. Dwelling on the idea that all 'taste' is essentially a perception of truth, I came to link the highest intuitions of human genius with the dim perceptions of the worm that gropes its way through the ground under our feet, and to regard as one and the same thing that wonderful faculty, by which each sentient creature, according to the measure of its capacity, feels, tastes, smells, hears, sees, or otherwise apprehends, the facts of its environment. From this point of view all creation assumed an aspect which was novel to me and very impressive. My thoughts simmered for many years, and at last they have boiled over into this book.

The five senses supplied the necessary framework for the theme and gave something like a plan to the sequence of thoughts, and they have also furnished a title for the book; but they are not the subject of it. At least the aim of the book is not to give an account of the senses. Indeed, my aim has not been to give an account of anything, but to present some familiar things in an aspect which is, perhaps, not familiar, and to impart a fuller meaning and more truth to the common use

of that class of words which we borrow from our senses and apply to higher purposes. I mean such words as 'taste,' 'feeling,' 'sense,' 'tact.'

To make the working of the senses intelligible, it was necessary to dip into some subjects with which every educated person cannot be assumed to be familiar, and hence arose the first of my two great difficulties. For no one who has not tried it knows the difficulty of clothing the most elementary truths of science in colloquial language, and of being simple, and clear, and interesting, without saying anything that is not true. If I have succeeded at all, I will risk the censure of having descended too far below the dignity of scientific precision.

The second difficulty was that of selecting and rejecting. The subject connects itself with so many of the interests of life, and suggests so many curious questions and attractive lines of thought that without a spacious waste-paper basket at hand and a good stock of firmness and self-denial, there appeared to be little prospect of ever coming to an end. And now that the work is finished, I feel that much has been left out that might have been said, and that much could be better said than

it has been. But to rewrite it now is out of the question for several reasons; so I conclude, with honest John Bunyan :—

> Well, when I had thus put mine ends together,
> I showed them others that I might see whether
> They would condemn them or them justify;
> And some said, Let them live; some, Let them die;
> Some said, John print it; others said, Not so;
> Some said, It might do good; others said, No.
> Now was I in a strait and did not see
> What was the best thing to be done by me.
> At last I thought, Since ye are thus divided,
> I print it will, and so the case decided.

Bombay: *July* 1898.

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FIVE WINDOWS OF THE SOUL

INTRODUCTORY

ON PERCEIVING

I SEE a little golden green fly, of fragile body and gauzy wings, which has lived one day and may survive another, resting drowsily on a leaf in the rays of the morning sun. It is waiting for the genial warmth to thaw the current of life within it, which froze and ceased to flow before the dew began to fall last night. The sun is some ninety-three millions of miles away, and as our world spins round him it catches an infinitesimal portion of his heat, as a sixpence held between the finger and thumb will catch a few of the rays from a distant lighthouse. And that fraction of the influence shed by the great luminary into all space evokes and

sustains the life of every tree and shrub, every man and beast, every living thing in short on the earth, down to this flimsy green fly. If the sun could be extinguished for even a few days all alike would die, and this earth would be one vast sepulchre. These are facts not to be denied. Nevertheless, I hold that this same green fly is a greater thing, a higher work of God, than the sun. For it can perceive the sun, but the sun cannot perceive it. And by virtue of that faculty the fly has a possession, a property in the sun, but the sun has nothing in the fly. It is also a shareholder, with myself and all perceiving creatures, in other things, many and various, in which the sun has no part or right How great a thing then is this faculty of perception! It makes the fly, in its little day, superior to all unperceiving things, and surely it makes man whatever he is. For is not Thomas Carlyle about right when he says, in his emphatic way, 'In fact, I say, that the degree of vision that dwells in a man is the correct measure of a man?' Looking at this divine faculty, as one may surely without irreverence call it, and tracing it from its first dim gropings in some lowly, formless, memberless being, through the successive stages by which the animal body is perfected, noting how it expands and advances and takes possession of one domain after another of the universe, seen and unseen; and

thinking of what may yet be in store for it in regions beyond our ken, I have felt tempted to cry out 'Eureka! Here is the very meaning and purpose of creation. To bring forth, in the fulness of time, a perfect perceiving being, has been the ultimate aim of the whole scheme.' However, I will be no propounder of new philosophies. Almost as little am I disposed to put forth anything in the form of a scientific treatise, having neither the requisite knowledge nor any other sort of fitness for such a task. I am only a man rambling in a mountainous country in quest of the beauties of nature, who has found a peak or point which commands a prospect sublime and enchanting. There is nothing new in it. He knows every hill and valley there. Their names are in the guide-book. But the aspect of them from this point of view is novel and charming. If there is in such a man the spirit of the four lepers who went out from Samaria into the camp of the Syrians, he will not be happy till he has brought his friend to that point and got him to admire each separate beauty of the scenery. My friend, I need scarcely say, is anybody who reads this book.

CHAPTER I

THE SENSE OF TOUCH

WHERE shall we begin? To us five ways are known by which knowledge of material things may reach a mind. We call them the Five Senses. Of these the first in order is surely the Sense of Touch. It seems to lead the way in our own development, and to be the innermost always and the nearest to our souls. And I believe it is the first of which any trace can be detected among the lowest forms of animal life. Let us then commence with Feeling.

But when we set ourselves to look for the first beginning of feeling, we at once get into a region which is still mystery to us and seems destined to remain so. Through a microscope we watch an amœba and see the minute speck of live jelly, without members of any kind, throwing out extensions of its soft substance, and laying hold of particles of food, and drawing them

Its first beginnings

to itself and absorbing them. It does more than this. Here is an account from Dr. Carpenter of the way in which it builds itself a house: 'We can scarcely conceive that a creature of such simplicity should possess any distinct consciousness of its needs, or that its actions should be directed by any intention of its own, and yet the writer has lately found results of the most singular elaborateness to be wrought out by the instrumentality of these minute "jelly-specks," which build up "tests" or casings, of the most regular geometrical symmetry of form, and of the most artificial construction. Suppose a human mason to be put down by the side of a pile of stones of various shapes and sizes, and to be told to build a dome of these, smooth on both surfaces, without using more than the least possible quantity of a very tenacious, but very costly, cement. If he accomplished this well he would deserve credit for great intelligence and skill. Yet this is exactly what these little "jelly-specks" do on a most minute scale, the "tests" they construct, when highly magnified, bearing comparison with the most skilful masonry of man. From the same sandy bottom one species picks up the coarser quartz grains, cements them together with phosphate of iron secreted from its own substance, and thus constructs a flask-shaped test having a short neck and a single large orifice.

Another picks up the finest grains and puts them together with the same cement into perfectly spherical tests of the most extraordinary finish, perforated with numerous small pores disposed at pretty regular intervals.' Further on, Dr. Carpenter says, 'we can only surmise that, in these humble rhizopods, as the whole of each "jelly-speck" possesses the attribute of contractility elsewhere limited to muscles, so may the attributes which are restricted in the higher types of animal life to the nervous apparatus be there diffused through every particle, the whole protoplasmic substance being endowed in a low degree with that power of receiving, conducting, and reacting upon external impressions which is raised to a much more exalted degree when limited, or *specialised*, in the nervous system.' But it does not necessarily follow that the amœba, or rhizopod, *feels*. If you touch the leaves of a sensitive plant they shrink and close up, and when a rat touches the spring of a gin it shuts with a snap upon the rat; but when we emerge from the blessedness of childhood we cease to believe that the trap feels the rat, and there is no reason to suppose that the plant feels your finger. There is a mechanism in each which is set in motion by a touch. And if anyone chooses to believe that that power in the rhizopod of 'receiving, conducting, and reacting

upon impressions,' in such a way as to lay hold of grains of sand and build them into most beautiful shells, is only a more cunning and complicated mechanism, unaccompanied by consciousness, I do not know how to answer him except by saying that I believe differently. There is no way of knowing what a rhizopod feels except by being a rhizopod, and that way is not open to us. I myself believe firmly that consciousness is that which separates animal from vegetable, as life is that which separates vegetable from mineral. Matter *is*, the plant *is* and *lives*, the animal *is*, *lives*, and *perceives*. But even this, if we were sure of it, would not help us out of our difficulty, for to this day, with all our scientific knowledge, we cannot draw a clear line between animal and vegetable. There are humble organisms of which it cannot be certainly said that they belong to one kingdom and not the other. It does not follow that there is no boundary; only that we cannot see it. The boundary lines of Nature are mostly invisible.

Happily, it is not essential for our present purpose to draw any definite lines at all. We know that we feel, and the behaviour of a horse or a dog leaves us in no doubt that it is like ourselves in that respect. As we go down the scale of life this evidence becomes less and less

distinct, till it disappears altogether, while the machinery of feeling, the nervous system, which in a horse or dog is very like our own, grows more and more simple, and finally ceases to be traceable at all. But there is no precise point at which we are justified in saying, 'Here consciousness ceases; these half-formed creatures cannot feel; they are mere automata, acting in a certain way because they are constructed to act in that way.' So we must just choose some point, and assume that in it we find the dawn of consciousness. Whether we are exactly right is of no practical consequence; nobody can fix to a minute even the dawn of day. We might well begin with the rhizopod, but I prefer a common sea-anemone. It requires no microscope. Anybody may find one for himself on the seashore, and bring it home and watch it with his own proper eyes.

The sea-anemone

It is not necessary here to go minutely into the structure of an anemone. There is not much structure about it. Its substance is a firm jelly and its shape that of a common jar, such as we keep jam in, with a fringe of soft arms, or 'tentacles,' all round the rim, like the petals of a sunflower. The circular space within this fringe, corresponding to the cork of the jam-jar, is the 'disc,' in the middle of which there is a slit, which we call the mouth because it is the

entrance to the creature's inside. It is the only entrance. There is no nose, for the creature does not breathe in our sense of the term, nor are there eyes, nor ears, nor any clearly discernible organs of sense. And the most careful dissection has failed to detect any clear trace of that special apparatus of sensation and action which we call the 'nervous system.' And if it has no nervous system, of course it has no brain. So whatever it does in the way of perceiving, thinking, and acting, is done in a general way by its whole substance, or by some apparatus too indistinctly separated from its substance to be clearly discernible by us. What does it do?

When you take it out of the sea to bring it home, its tentacles are all drawn in, and it is a shapeless, slimy lump; but put it in a glass and pour in water fresh from the sea, and it will presently open out like a flower and gently wave its hundred arms. It has no knowledge of your presence, nor of its fellow anemone near it, nor of the seaweeds and other pretty things in the aquarium with it, nor of the sweet tones of the piano playing in the room, nor of the merry laughter of your children; to it all these things are not. The soft feel of the water, its gentle motion, perhaps its temperature, too hot or too cold, these are the universe to your anemone. But drop a small

empty shell into the water, so that in sinking it will touch the point of one tentacle, and instantly that tentacle closes on it. The anemone's world has widened. It perceives the existence of something which is not itself and not the water. And you soon find that it perceives also some of the properties of that thing; for, after clutching it for a second or two, it relaxes its hold and drops it, whereas if you try the same experiment with a piece of raw meat, it will clutch tighter and tighter and draw the morsel inwards towards its mouth, which will open and admit it. Should a luckless shrimp come in contact with one of the tentacles, it will be seized in the same way, but as it struggles to free itself, other tentacles will close in and hold it fast, and altogether your anemone will display an energy which it did not display when it was dealing with the shell or the meat. It perceives not matter only this time, but *motion*. Assuming then that the anemone has consciousness, we find that it has perceived the existence of matter not itself, and of some of the properties of matter—resistance, hardness or softness, and weight, also of motion. So far it has penetrated into the mystery of things. This may not be its limit. At the points of its tentacles there are minute bristles, which must have some purpose, and at the bases of them there are 'pigment spots,' by some imagined

to be the germs of eyes. So the anemone's world may be wider and more interesting than we suppose.

The star-fish

As we climb upwards on the ladder of life, we find the whole structure getting more and more complicated, and very soon come upon a distinct apparatus of sensation and action. The star-fish, which wanders slowly over the rocks upon the shore, among the anemones, has round its mouth or throat a knotted necklace, or, to speak of it more respectfully, a 'gangliated cord,' from which slender filaments proceed to each of its five arms. The filaments are telegraph wires, and the ganglion, or ring of ganglia, the station where messages are received from the distant members and orders dispatched to the muscles that work them. Here is a simple, but complete, nervous system. When we get up a little further, among the worms, centipedes and insects, we find a very important extension of this system. A centipede consists of a great number of segments, like the links of a chain, each of which is supplied with one pair of legs ; and each of these segments has a ganglion of its own, giving off filaments to its own legs. Now it is evident that if each acted independently, receiving its own messages and giving orders to its own pair of legs, there would be complete anarchy in the body of that centipede.

The centi-pede

Each pair of legs would feel for itself and act for itself, without reference to the others, and the centipede as a whole could never go anywhere or do anything. If you pricked one segment, the rest would not know, nor care. Here is the necessity and use of a head; and perhaps the most important difference between the centipede and all the creatures that we have been considering up to this time, is that it has a head, which is the seat of a central ganglion, with authority to superintend and control the rest. From this a nervous cord runs down the whole length of the body, connecting the ganglia of the segments with one another and with it. So the whole centipede may be compared to a country divided into many provinces, each with its own government office and telegraph station, enjoying a certain measure of independence, but all subordinate to the head office at the capital.

The use of a head

Such is the intelligence department of a centipede, and as it differs very little, if at all, in principle from our own, we may profitably spend a little time in seeing how it works. When a centipede walks, each pair of legs moves just after the pair in front of it, so that it seems to the eye as if a wave of motion ran down the long row of legs, beginning at the head and dying away at the tail. If each pair of legs was

The nervous system

directed at every step by a distinct order from the head, the centipede, with its forty-two pairs of legs, would need to have a marvellously active mind; but there is really no such demand on its poor brain. Each pair of legs moves in obedience to the ganglion of its segment, and as they are connected together they act in concert, one immediately after another, producing a rhythmical motion of the whole. This motion is started, no doubt, by the head, but once started it goes on without the head; in fact it will go on just as well if you snip the head off. But if the body runs up against a wall, the want of a directing head will make itself painfully apparent to everybody but the centipede itself, for the headless creature will neither stop nor turn aside, but will continue to butt against the wall, just as a toy steam-engine will do in the same circumstances. There is much instruction in all this, but I will forbear to moralise at present. The experiment of snipping off the centipede's head has been varied by cutting through the nervous cord that connects the ganglia at some point about the middle of the body. In that case the forepart of the creature remains under orders and moves intelligently, but the hinder part asserts its independence. The two parts will walk together, but not harmoniously, and when the centipede wants to stop, the

refractory hinder part will continue to walk and push it on from behind.

From this and many other experiments, which have actually been made, it is clear that the actions of a centipede are in great part performed without any distinct intention or act of will. They are what are called *reflex actions.* An impression made on a nerve in one of the members excites a nervous centre or ganglion, which responds mechanically by starting suitable action in the muscles of that member. Each of these ganglia may be regarded, in fact, as a nervous mechanism for carrying on the common operations of life, and if the centipede is in any sense, as it assuredly is, an intelligent being, it is so by virtue of that supreme ganglion in the head, which controls and overrules all the rest. There lies the faculty of perceiving and acting upon perceptions. When a centipede whose head has not been snipped off meets a wall, it will not butt against it. It will perceive the wall as an inexorable obstacle to further progress in that direction, and will determine whether to go up or turn aside and run along it, and the whole body will be directed accordingly. Here, again, I will not moralise, but cannot resist the reflection how often a man's behaviour in similar circumstances indicates whether he has anything that can be called a head.

Reflex actions

As we go upwards still in the scale of life, from the centipede to the snail, and on, through fishes and reptiles and birds and beasts, to man himself, we find that progress is always in the direction of centralisation. Authority and independent power are taken more and more from the local centres, which dwindle away, and vested in the head office, which increases in size and importance till it becomes the brain of Aristotle. In other words, those actions which are performed in the lower animals mechanically and unconsciously, are performed in the higher animals by intention resulting from perception, and, in man at least, from reflection. Not all of them. Even we do many things without intention, by the reflex action of the nerve centres. We breathe, whether awake or asleep, without noticing that we are doing it. If anything irritates our throats or noses we cough or sneeze. The purpose of the performance in each case is to expel the irritating substance, but we do it not only without distinct intention, but even against our will. Many nerve mechanisms for performing actions of this kind, necessary for the maintenance and preservation of life, are still left to us, and they act without our interference. But there are many other things that are done equally mechanically by the lower animals, which we have to learn slowly

Progress upwards

and laboriously. A chicken gets up and walks as soon as it leaves the egg: we have to learn the art by much practice and many falls. The reason for this is that in a chicken the various movements by which the balance of the body is kept are, in a measure (only in a measure; a chicken walks very unsteadily at first), reflex actions, like a sneeze or a cough; whereas a child has to pay attention to what it is doing, and to counteract any overbalance on the one side by a movement on the other. In time the nerve centres will learn to respond of themselves to their sensations, and then the conscious brain will hand over the business of walking to them almost entirely, so that the child will be able to walk while its attention is busy with other things. However, we need wander no further along this track. We have really nothing to do with reflex actions or with actions at all. I have glanced at these things only for the purpose of putting aside those sensations which, though they may start the body into action, do not address the mind. By the way we have picked up this weighty truth, that, in all animal life, there is much action independent of perception; but the highest life is that which is most controlled by the faculty which perceives before it acts. We may now take leave of action altogether, and consider *how* we feel.

When anything outside of me comes into contact with any part of my body, my mind at once has intelligence of its existence and situation and of some of its properties, whether it is hard or soft, smooth or rough, hot or cold. The mind has its residence, let us say for want of fitter words, in the brain, and the object of which it has gained knowledge has touched the skin which is the outermost boundary of its territory, the body; but these are connected, as we have seen, by a system of fine fibres called *nerves*, which put them into communication with one another. One end of each fibre is merged in the brain; the other enters the skin, not the outer skin, which is only a wrapper, but the inner, true skin, or *cutis vera*. Here it ends in something about the nature and workings of which the most powerful microscopes have left us little wiser than before. So much we know, that when that something is irritated we *feel*. There is one thing, however, about which we ought to keep our minds perfectly clear, and it is this, that the feeling is not in the nerve, nor in any part of the skin, but in the *brain*. It is very difficult to bear this always clearly in mind, because we have been accustomed from our infancy to think that we feel where we are touched; but this is a delusion, as has been proved in many ways. A medical

How we feel

Feeling is in the brain

friend of mine in the Edinburgh Infirmary was carrying back to his bed a little boy whose leg had been amputated. As he began to recover from the effects of the chloroform that had been administered to him, my friend asked, as cheerily as he could, 'How do you feel now?' The answer was, 'I hae got a sair tae.' His toe was in the operating room, and nothing that could happen to it would ever trouble him more; but the nerve that used to bring his brain news from his toe still ran down his leg as far as his thigh, and when it reported unkind treatment by the surgeon's knife, the brain took for granted that the message came from the toe as usual, and *felt* the pain there. When that boy had many times tried to scratch his toe and missed it, he would learn to look for the pain, and find it at the end of his poor stump of a leg, and gradually he would grow to feel it there. Another, rather ludicrous, case of the same kind occurs when a surgeon gives a man an artificial nose. In this operation a piece of skin is cut out of the forehead, leaving only a narrow strip to connect it, and is then turned down and used to clothe the new nose. The skin soon grows to its new situation, but in the man's brain its nerves are still the nerves of the forehead, and if his nose is pricked he scratches his forehead. When any set of nerves is cut through or destroyed by disease, all that part of the body which

they supply loses sensation. From these facts it is clear that we do not feel where we think we feel. The mind sits on its throne in the brain, holding a thousand wires from all parts of its dominions, and as messages come from one and another, it registers them and interprets them into feeling, and associates them with the place from which they have come. This association has become so strong in us that we cannot now separate the feeling from the place, but there can be little doubt that it was formed at first by a slow and gradual process. According to Tennyson :—

Learning to interpret sensations

> The baby new to earth and sky,
> What time his tender palm is pressed
> Against the circle of the breast,
> Has never thought that 'This is I.'
>
> But as he grows he gathers much
> And learns the use of 'I' and 'Me,'
> And finds 'I am not what I see,
> And other than the things I touch.'
>
> So rounds he to a separate mind,
> From which clear memory may begin,
> As, through the frame that binds him in,
> His isolation grows defined.

When the baby has thus established his identity, his next step, I take it, is to get acquainted with all the parts and powers of that 'frame which binds him in.' I imagine that at

first a baby, as it lies on its back slowly following with its eyes that moving object which will afterwards be Mother, has only the vaguest notion, if any, of the directions from which the many confusing sensations come which play upon its brain all the day. But by degrees it learns to locate them. When it gets the length of knocking its little hands against each other or catching its own toes, it starts two simultaneous sensations, which throw light on each other, and that helps it on wonderfully; progress is more rapid after that. So sensation becomes perception, and the little soul enters by degrees into full possession of the capacities of that marvellous body, through which it will take possession, in its measure, of the universe.

After leaving the skin the nerves meet each other and combine into nerve trunks; but they do not unite. Each is insulated from all others as carefully as the wires in a telegraph cable, and carries its own message without confusion to the brain. It does not follow that the brain keeps them quite distinct. That is a question of education—the education of the sense of touch, which, though it begins in babyhood, does not end there. It goes on all through life under very various teachers. A pebble in my shoe, a fly lighting on my bald pate, an uncomfortable

More advanced education

wrinkle in some part of my underclothing—I recognise them all as instructors setting me to analyse my sensations and ascertain the nature and exact position of the object causing them. Some men make more progress than others, and acquire a far more discriminating sense of touch, and all men discern more accurately through some parts of the skin than others. This is partly, no doubt, because the sensitiveness of one part is more cultivated by circumstances than that of another, but it is due chiefly to the fact that some parts of the skin are much more richly supplied with nerves than others. The duties of some parts are passive, and in these the nerve centres, like the telegraph stations in a rural district, are few and simple. Other parts, like the hands, are active, not only feeling what happens to them, but going out in search of intelligence; and in these the nerve centres are thickly crowded together. The difference in this respect between different parts of the body is surprising. Anyone may test it in a very simple way, by shutting his eyes and getting a friend to touch him with the points of a pair of compasses, while he tries to guess whether he is being touched with both points or only one. He will find that with the tips of his fingers he can feel the two points distinctly when they are less than one-

Differences in the sensitiveness of different parts of the body

tenth of an inch apart, while on the arm they may be separated by more than an inch, but he will only feel one impression. The tip of the tongue feels even more delicately than the finger-points, and the lips also are very sensitive. The dullest part of the whole body is the back ; there the compasses must be opened about two inches before one can distinguish the points. By the sensitiveness of the skin of the finger-points we are able to discern the nature of a surface. For example, a pane of glass touches the skin equally all over, but a nutmeg-grater touches it at ten or twenty minute points close together. All roughness is just the nutmeg-grater in another degree.

The sense of pressure

But it is evident that if we could feel nothing else than the contact of a substance with the skin, there would be little difference to us between a pane of glass and a satin pincushion. We distinguish these by the *sense of pressure*. The connection of this with the sense of contact is obscure. The nerves of the skin end in several different kinds of machines to which hard names have been given, 'Pacinian corpuscles,' 'Wagner's cones,' and so forth ; but these names bring us no nearer to a knowledge of what their precise functions are, and wherein they differ from each other. So much, however, we know—and it is enough—that we have some means of discerning with what

degree of force any object is pressing on the skin. In use this sense is mixed up with another, which we may call the *muscular sense*. If I take up a pound of lead in my hand I feel in some way the degree of muscular effort required to support it. Put a pound of feathers in its place, and the muscular effort will be the same, but the pressure being distributed over a much larger area of skin the stress of it on my flesh will not be so severe. These two things are, of course, quite distinct, but they are so closely associated in practice that they are generally rather mixed up in our minds too. Any man taking up two leaden weights, one in each hand, can tell pretty correctly whether they are equal or not; but very few men can take a leaden weight in one hand and a loaf of bread in the other, and say whether it is an honest pound loaf or not. A shopkeeper will do it much better than another man, because he is constantly handling pound parcels of various goods, and his sense of weight is better educated, or, to speak more correctly, his mind is more skilled in discriminating and interpreting his sensations.

The muscular sense

There is yet another kind of knowledge that comes to us by way of the skin, but possibly along a channel of its own, which deserves the name of a separate sense. By means of special nerve-

points, it seems, distributed among the nerves of common feeling, we can detect with wonderful nicety the passage of heat inwards or outwards. When anything colder than our blood presses against any part of the body, it steals heat from the skin and the nerve-points are chilled; but a hot thing gives us of its heat and the nerve-points are warmed.

The sense of temperature

The nerves that send to the brain all these sensations are distributed over the whole surface of the body, and their office is to give immediate intimation of assault by heat, cold, thorns, or anything else hostile or injurious. This is the primary function, perhaps, of all the senses, to give warning of danger. But life is not negative, and nothing can live by only avoiding evil. Everything that lives must also seek good—its good—or perish. And the nobler the life, the higher and more diversified will be the good that it must seek. For wherein is one life higher and nobler than another, if not in the amplitude and scope of its capacity to perceive and desire and enjoy? So no sense remains passive. Life has scarcely emerged from its lowest and most rudimentary manifestations, when the nerves of touch are collected in force at convenient points for the active work of investigating the nature of things. In insects the chief tactile organs are sup-

The active use of the sense of touch

posed to be the antennæ—supposed only, for we know little about them. The tongues, too, of flies appear to be sensitive, and the 'hands' with which the spider 'taketh hold.' In fishes and reptiles, scale-clothed or horny-skinned, I imagine that the sense of touch is almost in abeyance, as is hearing, their one keen sense of sight being enough for their needs. It revives in birds, which feel things examiningly with their beaks and tongues; parrots do this especially. Beasts are endowed with special sensitiveness about the region of the nose and lips, some more in one part and some more in another. A horse feels with its lips, a hog with its snout, an elephant with its trunk. When a rabbit notices anything strange in its hutch, a new feeding-trough or the like, it examines it by rubbing its chin against it. But nowhere among living beings is there to be found another exploring instrument comparable to the hand of man, with its five fingers moving every way, like complex compasses, and measuring their own movements, with its delicate pressure pads and the exquisite sensibility of its tips. I shut my eyes and ask a friend to put something into my hands. As soon as my fingers have closed on it I know, by the force necessary to keep it from slipping through them, that it is not heavy enough to be metal or stone, nor is it cold

The human hand

enough for these. The pressure on my finger-points assures me that it has not the hard, unyielding surface even of wood. Running my fingers over it, I ascertain that it is four-cornered, and form a pretty correct estimate of its dimensions every way. Testing its surface again more delicately with the point of my second finger, I decide that it is covered with something like smooth leather and embossed in the centre. It is *an album!* But the sense of touch in me is like a neglected child, who has grown up uninstructed and undisciplined except by the rude discipline of everyday life. What it might be trained to, what clearness of perception, what delicacy of discrimination, what accuracy of measurement, we learn occasionally in some degree from those whose eyes are sealed! I lately visited an asylum for the blind, and watched the long rows of darkling workers at their different trades. Here was a basket-maker repairing a dilapidated basket. He took in its weak places at a glance of his fingers. Unerringly his hand went down and found the short measuring-stick at his side, and he measured his work, cut his osiers, and began to run them in at one side and out at the other, till I turned to ask the overseer if those blank, open eyes were really sightless. At another place was a brushmaker, with a handful of bristles

Keen sense of touch in the blind

in one hand, out of which he took with the fingers of the other the exact quantity required for one tuft of the brush, then, catching up the half-made brush that lay near him, and running a wire through the next vacant hole in it, he rapidly caught the tuft of bristles in the wire, and drew them tight in their place, with all their ends equal, not one long and another short. Wooden backs, bristles, wire, and all other things requisite, were lying about him on the ground, and his hand pounced on what he wanted as if it were itself a seeing thing; for, when he last laid any article down, his brain took note of all the streets, turns and crossings, down the muscles and tendons of his arms, and it had no difficulty in finding the way again. What struck me most about these people was the rapidity and concentration of mind with which they worked. It told of enviable freedom from the distraction that comes by the wayward eye, and it carried my thoughts to another busy race of blind workers, which we call in the East 'white ants.' How marvellously do they sink their pits and push their mines into the bowels of the earth, and smooth and plaster the walls of their vaults and chambers; and, bringing up the excavated earth, build with it a stupendous pile, beside which, if we measure the work by the workers, the Pyramid of Cheops deserves to be called a goodly

White ants

milestone—a pile in which dome rises upon dome, and great vaulted highways, planned for the passage of armies, break up into a perplexity of echoing corridors, winding staircases and intercrossing galleries. And with what audacious contempt for difficulty and toil do they enter on expeditions to unknown regions, traversing the walls of men's palaces and ascending the trunks of giant trees, ever building, as they go, covered ways of wondrous brickwork to shield them from the light, which, giving them no guidance, would betray them to their countless foes. Such miracles of material labour are not for man, as he learned early on the plain of Shinar, for his true path to greatness lies another way. But what limit shall we put to the possibilities of perception that would have been his had he been shut up in this wonderful world with no window to his soul but the sense of touch alone? It is perhaps vain to speculate. Sound, no doubt, would have remained for ever unknown, and colour too; but not music nor beauty. The music of rhythm would have been quite apprehensible, and how keenly enjoyable none but a deaf man can well imagine, and beauty of form also it would have been given to him to discern and delight in. And the laws of form and numbers—all mathematical science, in short—would have been as open to him as it is to us. But as

Possibilities of the sense of touch

bows and arrows were discarded when firearms came into use, so we do not employ our sense of touch when another can serve us both more rapidly and more certainly. Still there remain to the last regions which no sense can penetrate but this. Our first apprehension of some of the most fundamental properties of matter come to us by it, and can come in no other way. Weight, solidity, hardness, are conceptions which neither hearing nor sight could have introduced to our minds.

Pleasure

There are two sources of pleasure given to all living creatures, two perennial springs of happiness which make all healthy life a glad thing. These are, the exercise of our perceiving faculties and the exercise of our active powers. With the second we have nothing to do here, and with the first not much as yet; for the avenue which the sense of touch opens to pleasure is but a narrow one. And yet it is the beginning of all, the first in order of creation or evolution, and still the A B C of the subject. Our very language shows this. We speak of 'feeling' pleasure, and being 'touched' by kindness. And for this very reason, I think, this sense, in its experiences of pleasure, discloses some foundation principles with a clearness which may help to light our way further on.

First, let us note that a *gentle* excitement of the

sense of touch gives pleasure. There is no enjoyment in handling a chair or a table; but when the touch is gentle and the sense sensitive, so that the mind must turn towards it to feel it properly, there is a distinct thrill of pleasure. The feel of smooth and soft things, velvet or satin, is pleasant to the finger-points. Still pleasanter is it to feel fingers passing gently over the back of the neck, or about the ears, where the skin is sensitive. Animals are very susceptible to this kind of enjoyment. Everybody who has kept rabbits knows how easily their hearts are won by gentle tickling behind the ears. In a much-petted rabbit the craving for this stimulant or narcotic, whichever it be, grows into a vice which enslaves the poor creature body and soul. A horse keenly enjoys the same kind of treatment on the point of his nose, and the most savage cockatoo is subdued if you can once get your fingers insinuated under the feathers of its crest.

A second point is that, if the gentle excitement of the nerves of sense is pleasure, pain is nothing but a stronger excitement of the same. So pain is not the opposite of pleasure, but the same thing in another degree. And pleasure reaches its climax just when it is on the point of passing into pain. The excitement of a tender nerve becomes more and more pleasurable

Pain

until it reaches a point at which we can bear it no longer, and it becomes pain. Shall I turn aside here to see how, by some natural law in the spiritual world, the same truth holds in the region of our higher emotions; how the poet, the novelist and the dramatist

> Make the delighted spirit glow,
> Till joy denies itself again
> And, too intense, is turned to pain?

No; I will not. The temptations to look down the crossways and by-paths of this subject are so many and so fascinating that I must not yield to them.

The third point, which seems to me most significant, is this, that the position of the line at which pleasure passes into pain depends upon the sensitiveness of the subject, and so that which gives delight to one will be agony to another. A horse and I differ in our opinions about the curry-comb. He thinks that it imparts a pleasurable sensation to the skin: I can scarcely imagine a more horrible torture than to have one's back raked with such an instrument. Neither of us is wrong, and there is no occasion for bigotry. The difference is in ourselves. My skin is thinner and my sensibilities are finer, that is all. This may seem childish and simple, but I tell you it is a luminous truth, and we shall find much use for it further on; so let us carry it with us.

There is yet one function of the sense of touch, the highest, which I almost fear to handle; but it cannot be passed by. I am not prepared to dispute with Theosophists and Spiritualists that soul may speak to soul without any bodily go-between; but one thing that I am quite sure of is, that I, and a multitude of commonplace souls, have to depend mainly upon our senses for the means of intercourse with one another. My friend makes sounds with his mouth that my ears may catch them, and his thoughts and feelings become mine. My eyes twinkle and my lips smile, and he, looking on my face, knows the answer of my heart. Nay, I take a pen dipped in ink, and, making crooked lines upon a piece of paper, drop it into the letter-box over the way, in full confidence that the day will come when he, by looking on those marks of mine, will know how my heart felt towards him. What an infinitely wonderful thing is *speech*, that equipment of *words* by which—spoken, written, or engraved—we may pour out the fruit of our minds and hearts into the audible, visible world, where our fellow-men may glean them. It is that, more than all else, which lifts the meanest creature that is called *man* up into a region apart, where the dumb animals have no fellowship with him. God brought unto Adam every beast of the field and every fowl of the air,

Communion

and Adam gave names to them all; but among them all there was not one that could give a name to Adam, and so there was not found an help-meet for him. All this is true. And yet what is the meaning of that cry,

> Oh! for the touch of a vanished hand?

It means that, when words have told all that words can tell, there may be something left which can only pass from heart to heart by a shorter and straighter road, something which instinctively falls back upon the first and humblest of our senses and confesses our kinship 'after the flesh' with every beast of the field. The words of love are sweet, but

> Our spirits rushed together at the touching of the lips.

How vapid is all Romeo's love-eloquence beside that one thought,

> See, how she leans her cheek upon her hand!
> O, that I were a glove upon that hand,
> That I might touch that cheek!

So friend grasps the hand of friend; the lover wants to feel the beloved cheek with his lips; the child, untaught, throws its arms round the neck of its mother, and the mother hugs the child to her bosom. The New Zealander, when he brims over with friendliness, seizes your head in his hands and rubs his nose against yours.

CHAPTER II

THE SENSE OF TASTE

We have seen that, if a dead shell is let fall upon the tentacles of a sea-anemone, it will clutch it, but almost immediately let it go again ; whereas, if it captures a live shrimp, it will hold it fast and thrust it into its mouth. But sometimes, when it has secured a morsel of doubtful quality, I have seen it take it into its mouth and eject it again. From this I infer that inside of the anemone there is some organ for perceiving the properties of matter, with reference especially to its fitness or unfitness for nourishing anemones, and that that organ is more sensitive or more trustworthy than the tentacles. And happily the anemone has the power of undoing its errors and turning out of its stomach anything which it has unadvisedly let in. But this, after all, seems a very clumsy way of managing one's house—to take in every passing stranger, without inquiry, and kick him out when you find that he is a tramp. Better to post a door-

keeper at the entrance, and let nobody in until you are assured that he is worthy of your hospitality.

Situated in the mouth

So says Nature, and before we have gone many steps up the scale of life we find a sense of taste located in the mouth to examine all foods and pronounce upon them before letting them proceed further. As to the construction and working of this sense we are, if possible, more ignorant than we are about the sense of touch. The tongues of dogs and pigs and cows, the mouths of worms, the proboscis of the bee, the maxillæ and palpi of many insects, have been taken to pieces and forced to present the very texture of their substance, magnified many hundredfold, to the acumen of scientific eyes, and the net result, as far as I can gather, is a vast number of drawings of 'glandular hairs,' 'chitinous tubes,' 'ellipsoidal nuclei,' and so forth, with appended suggestions that this or that is *probably* an organ of taste. On the tip and the back and other parts of the human tongue there are numerous excrescences, which have been called 'taste-buds,' and these are found to be resolvable into bundles of long cells, some of which send down very fine fibres into the substance of the tongue, which *perhaps* meet the terminal fibres of a very important nerve (called for simplicity, the glosso-pharyngeal), whose office it is to carry the sensations of the

tongue to the brain. But we have no knowledge how these cells, nerves and fibres act. Are minute particles of the food dissolved in the moisture of the mouth, and do they act chemically on the substance of those tender 'taste-buds,' as acids corrode the substance of the skin? If so, how are the different kinds of action distinguished? It has been suggested that there is a separate nerve-fibre with a different kind of ending, for the detection of each kind of action—one for sour, another for bitter, another for sweet, and so on. But, if we accept this explanation, it will land us in sad perplexity when we come to the sense of smell.

Let us leave what we do not know and pass on to what we do know. There is no sense which makes its almost universal presence in animals of every rank more plain to us by outward signs than this sense of taste. If you take a hungry caterpillar and put it on a plant which is not its proper food, it will seek the edge of a fresh leaf and take a bite out of it. If the leaf is rather like its proper leaf in quality and flavour, it may take three or four bites, then, perhaps, leave that leaf and seek out a more tender one and repeat the experiment on it. After that it will refuse to feed on that plant, though the alternative should be death by starvation. Sir John Lubbock says that no one who has watched

Universal

a bee or wasp can entertain the slightest doubt that those insects possess a sense of taste; but, if it needed proof, Forel and others have proved it by playing many unkind practical jokes on them, and also on ants, offering them honey mixed with strychnine, quinine, and other nasty stuffs. For myself I have never seen any reason to doubt that insects of all kinds, which either chew their food or suck it in a liquid state, enjoy the power of testing its quality. It is not so easy to see the use of taste to an animal that swallows its food whole. To a snake, for example, it would seem to be a matter of little consequence whether the frog which is sliding down its throat alive has the flavour of a grouse or a crow. Yet frogs and lizards, if not snakes, are fastidious feeders, and many kinds of insects are saturated with a nauseous savour for no other reason, as far as we can judge, than that they may be distasteful to these reptiles. Birds, for the most part, swallow their food whole, yet they are very particular about the taste of it. A hen, picking up grains of corn so fast that you fancy they must shoot the passage of its throat like bullets from a Maxim gun, detects at once whether the corn is fresh or musty.

Still, I think we may assume that the sense of taste is more highly developed in beasts, which eat slowly and chew their food, than it can be in

either reptiles or birds. And there can scarcely be a doubt that it is still more perfect in man. His original faculty may not have been greater, but a liberal education, continued through many generations, has brought it to a delicacy of discrimination which is really wonderful. Brillat-Savarin tells us of epicures in Paris in his own day, who, when they ate a partridge, could tell on which leg it had been accustomed to sleep ; and it is said that one part of sulphuric acid in a thousand parts of water can be detected by the tongue in a single drop. And there is practically no limit to the number of flavours that we can distinguish and remember and recognise again.

Most highly developed in man

Thus materials are gathered, out of which experience may be built up. But the sense of taste does something more than accumulate data for experience. The distinctions which it perceives are not indifferent. By some adjustment, which is still among the mysteries of our being, the instincts of the tongue are in alliance with the constitution of the stomach, so that it finds pleasure in the sensations excited by those substances which are wholesome, and is offended by those that are injurious. It appears, then, that the investigations of this sense have reference, not so much to the

The dawn of conscience

inherent properties of substances, as to their suitability or unsuitability to our constitutions. And this, I hold, is a first glimmering of a kind of moral perception. For everything which is offered to the mouth as food is in that relation either good or bad, right or wrong. If right, it is to be approved and accepted, and will bring its reward; if wrong, it is to be disapproved and rejected, else we shall not escape punishment. In this department, then, the sense of taste is conscience, and to decide between good and evil is its high function. Among the lower animals its voice speaks in accents of authority, and they obey. Among ourselves, alas! it is not always so, because we have 'sought out many inventions' and depraved our simple perceptions.

The æsthetic perceptions of the sense of taste

As customs officer at the chief port, examining all imports for contraband goods, the sense of taste is constantly employed in duties so important for the welfare of the body that it would be contrary to what we generally see in nature if it did much outside its own office. It is a very general law of the physical distribution of labour that miscellaneous duties are committed to those organs which have most time on their hands, so to speak. But I would not say that the sense of taste perceives nothing outside the routine of its own office. For example, it

classifies tastes under certain general heads, as sweet, sour, salt, bitter; and these do correspond roughly with distinctions in the chemical composition of the substances themselves. And it must surely be a perception of real affinities that guides mankind with common consent to pronounce certain combinations to be suitable and others unsuitable. Why do we take mustard with beef but not with mutton, mint sauce with lamb, pickles with cold meat? In a recent book on the partridge, in which that bird is treated from the sportsman's, naturalist's, and epicure's point of view, twenty-two pages (of which Mr. George Saintsbury is the author) are devoted to the cooking of it. From these I make the following extract:—

'There is yet another point in which the excellent Markham shows his taste. He prescribes as the best sauce for pheasants or partridges water and onions, sliced proper, and a little salt, mixed together and but stewed upon the coals. "To this," he says, "some will put the juice or slices of an orange or lemon, but it is according to taste, and indeed more proper for pheasant than partridge." This at once shows a perception of the root of the matter in game cookery, a perception which was not too clear even to Markham's countrymen in his own day, and which, though we

have gradually waked up to it, is constantly dulled by contamination from abroad. It cannot be too early or too firmly laid down that, in the case of all game birds, but especially in those which have the most distinct character and taste, the simplest cookery is the best.'

Now what is the meaning of all this? What is it that this man discerns when he rejects even the juice of an orange or lemon as an accompaniment to the roasted flesh of a partridge, but allows it with a pheasant? He is evidently quite confident that the combination which he commends will be approved by a few select persons who have devoted their attention to the study of the sensations produced by eating partridges, and whose opinion is of more value in his eyes than that of the majority of Englishmen and all Frenchmen. In short, he is just as secure in his position as was Hamlet when he condemned a style of acting which, 'though it split the ears of the groundlings, could not but make the judicious grieve,' for he feels that 'the censure of one such must overweigh a whole theatre of others.' And there is a principle clearly discernible under his judgment, which is this, that when a man eats partridge he wishes, or should wish, to enjoy the flavour of partridge, and therefore the cook's business is to combine with it no flavour that will interfere with it

but rather those that will serve as a foil to give it greater prominence. What things will do this can only be determined by an acute and highly cultivated sense of taste. Science cannot do it; science can only explain and verify the judgment of taste. And when we know all the chemical principles that impart their respective flavours to partridge meat, onions, and lemon juice, and when we understand the precise action of each on the nerves of the tongue, then I have not a doubt we shall find a reason, based on scientific truth, for the judgment pronounced by the clear perceptions of the sense of taste.

Why is the sense of taste in ill repute?

But if the sense of taste, besides all its practical usefulness, is capable of forming right perceptions which rejoice the heart, as all right perceptions must, then why do we not hold it in more honour? This question has puzzled me much. It is a melancholy fact that this sense has a very shady reputation. It is the pariah among the senses. Secretly many of us entertain a very high regard for it, no doubt, but we are ashamed to admit this. By common consent we affect to despise a man who reveals any high degree of esteem for it, and we honour a man who treats it with contempt. Considering well of the matter, I am led to the conclusion that this poor sense of taste is a victim of unfortunate

circumstances. While the other senses range abroad, it is imprisoned in the mouth, and has no employment but with meats on their way to the stomach. If it pronounces these to be good, the man eats too much of them, and then, like Eve, throws the blame on the tempter. Yet the tongue might be his guardian instead of his tempter, if he treated it fairly; for there is in it a wonderful self-adjusting contrivance, by which pleasure would cease as soon as he had had enough, and turn into loathing, warning him to stop on pain of direful consequences. If this contrivance does not always work, I suspect it is because man mingles with his food flavours that do not belong to it, with the very design of tempting his tongue to tempt. And here I see clear justification for the principle that seems to underlie Mr. George Saintsbury's opinions about the cooking of partridges. If we followed that principle in all things, and allowed our food to present itself on its own merits, without foreign recommendations or spurious certificates, then our palate would not only guide us to regulate our eating wisely, so that it should do us good and not harm, but would also extract from it that pure enjoyment which is intended to accompany all the functions of a healthy life.

CHAPTER III

THE SENSE OF SMELL

So far we have seen life groping with blind hands, or feelers of some sort, among the multifarious things about it, perceiving them and taking knowledge of them as things to be avoided or things to be possessed and enjoyed. In the latter case we have seen it arresting them and taking them into an inner chamber to be tested more carefully as to the qualities of their substance. Wonderful as these powers are, their range is very limited, for they are bounded by the bounds of the body. Ways may indeed be devised of coming at a knowledge of things beyond the direct reach of any bodily member, as a blind man feels the road with a stick, or a spider feels a fly struggling at the furthest corner of its web; but the limits of even these means are soon reached, and the indirect and second-hand intimations which they convey are at the best vague and uncertain. But everything that lives is steeped in an atmosphere of some kind, air

or water, and all, or nearly all, substances are for ever giving off inconceivably minute particles into that atmosphere, which drift about with its currents. Could some of those sensitive nerve-points in the skin not be made so sensitive that they might feel these minute particles and test their qualities, and so gain knowledge of things quite beyond the reach of the members of the body, even as Columbus gained knowledge of lands in the west from fruits and leaves carried to him by the waves of the sea? It has been done, and we call this new perception the Sense of Smell.

Particles in the air

But who, standing in the morning of life, when the invention was new, if I may so speak, could have foreseen the wonderful developments of which it was capable? It would have been easier to forecast what time had in store for Watt's first steam-engine. A dog puts his nose to the ground at a place where it was pressed by the sole of a shoe an hour ago. Some atoms of leather, it seems, remained adhering to the ground after the shoe pressed it, and these have been giving off particles, atoms of atoms, ever since into the air. The dog catches a few of them with his nose, diagnoses them, and perceives, not only that they are leather, but that they are the leather of his master's shoe; and this he does so instantly and unerringly that the work of catching

An organ for perceiving them

up and recognising these particles at the successive places where the shoe touched the ground keeps him at a gallop. There is something like an infinity of subtilty in this: it defies conception. I have read in a book of a scientific man, named Valentin, who set himself to reduce the powers of his own nose to figures, and found that he could detect 'the three one hundred millionth of a grain of musk.' I leave him, who can, to extract an idea out of that. This is certain, that there is no scientific process we know of which can approach even the human nose as a detective of minute particles of matter.

The birth-place of the sense of smell

But perhaps the organ of smell is not a refinement of the nerve-points in the skin, but a variation of the taste-buds in the mouth, for the properties of matter which we detect by it are closely related to those which affect the sense of taste. Or it may be different from both, a distinct invention. The list is long of earnest men who have laboured with dissecting knife and microscope over the olfactory nerve and the lining membrane of the nose; but as yet we know just exactly nothing at all of the process by which a gas coming into contact with that membrane becomes a sensation of smell in the brain. It might help us, at least it would be interesting, to find out where the sense of smell first appeared;

but even this no one has yet been able to do. That insects smell is plain. The sweet scents of flowers are without doubt an advertisement addressed to bees, butterflies and moths. Cover up putrid meat as you will, the flies will find it. But with what part of them do these creatures smell? They have no noses. Insects breathe through holes in their sides, called spiracles, and it was natural to suppose that they must smell through them too; but a good deal of evidence has been brought forward to show that this is not the case, and at present opinion appears to be divided as to whether they smell by their antennæ or their 'palpi'—those two little fingers that point forward from their faces—or whether the sense of smell is more or less in both. If it is in that region at all, then there is encouragement for the idea that smell is a branch, or offshoot, from the sense of taste. And almost all the other evidence points that way. The scent of flowers is just an emanation from the nectar on which the butterfly feeds, a sample sent out to attract custom. Surely the sense that tries the one must be akin to the sense that enjoys the other. Doubtless when the little creature thrusts its slender trunk down into the flower, both senses combine to minister delight. And do the lovely tints of the dish from which it feeds not bear a share too? It is hard to say; but I should be sorry to believe

otherwise. That, however, is ahead of us yet; we shall come to it further on.

If the emanations of pleasant food are delightsome to the sense of smell, those of things injurious or unwholesome are, on the contrary, repulsive. Insects hurry away in distress from the odour of turpentine, tar, camphor, tobacco, and many other things which, though harmless, and therefore inoffensive or even pleasant, to us, would be hurtful to their delicate constitutions. It is indeed worth noting how generally, though not universally, the sense of smell gives warning of things that would do us harm. Almost all poisonous fruits have an odour which is offensive to us, and this is true even of the flowers and leaves of poisonous plants. The smell of those things which are wholesome only in the smallest quantities, like spices, is generally delicious in moderation, but becomes intolerable when too strong. How generally, too, does a pronounced difference of taste, with respect to smells, mark a difference of constitution. Putrid meat is poison to us, and therefore the odour of it is loathsome; but the vultures that sail over Araby the blest find no incense there so sweet as that which rises from a dead camel.

But the sense of smell is not imprisoned, like the sense of taste, and needs not to confine itself to food and poison. It gathers all the waifs of the

air and finds many things to interest it. All enemies have odours of which they cannot by any means rid themselves, which go forth like heralds and give warning of their approach to those who have the wit to take it. For them this subtle sense soon learns to watch, and with what effect every sportsman has good reason to know. With a bush or a rock to help him, he may elude the eye of his game, however wary ; but unless he is careful to make an ally of the wind, it is vain to hope that his approach will not be discovered by its nose. And friends as well as foes have odours by which they may be recognised from afar. Every collector of moths knows that. Other things, also, all things, in fact, which are of any interest, may be recognised and sought out by their odour, and then, by association, loved for it. That heavy, carnivorous smell, which has often arrested me in an Indian jungle, means 'home, sweet home' to some tiger or hyena.

Its range

Now we must go back and trace the development of this sense upwards. There is no reason to question that all animals, above the rank of insects at least, have an organ of smell situated in some part of their bodies. Those that inhabit water are not excluded, for smells travel by water as well as air. I have often called together a hasty meeting of the shrimps and hermit

Its development

crabs in my aquarium by putting down a piece of raw meat where they could not see it.

But these and all creatures below the rank of frogs and reptiles breathe through holes in their sides, or by gills of some kind, and if their sense of smell must be situated near the mouth, it can only catch such odours as the wind or chance may bring past it. A very great advance becomes possible when the breathing holes are taken from the sides and placed in the nose, close by the mouth. For now the organ of smell can be lodged about their entrance, to waylay every breath that is drawn into the body and examine what it carries. Nevertheless reptiles do not seem to have much sense of smell; they are dull in everything but sight. Birds, though by no means dull, are also a little deficient, I think, in this sense, the reason being, perhaps, that they live for the most part at some height above the ground, where the pure air gives little exercise to their noses, and a clear view in all directions encourages the use of their eyes. But in beasts we find the sense in its perfection. The apparatus of it has, as I have already said, been most minutely examined and described, though the secret of its working has never been penetrated. The sensitive region is in the upper part of the nose, which is divided into several chambers, lined with a moist, velvety membrane,

The mechanism of it

similar to that which lines the mouth, a membrane most wonderful in its texture, yet so meaningless to us. From this membrane fine nerve-fibres, uniting into trunk nerves, make their way upwards, through holes in the bone between the eyebrows, and have their roots in a special lobe of the brain, called the olfactory lobe, where their messages are interpreted into perceptions, and recorded in the archives of the memory for future reference. I need scarcely mention that the nose is connected by an open passage with the mouth, so that, as food is crushed and mashed and prepared for swallowing, every odour it exhales passes up to the sense of smell, which has quite as much, or indeed a good deal more, to do with our enjoyment of eating than the sense of taste has. The two work together and we scarcely distinguish them, but it is very doubtful whether the palate by itself could take note of anything more than those principal divisions of tastes which we distinguish as sourness, sweetness, bitterness, &c. The bouquet of wine, the aroma of fresh-ground coffee, and all delicate flavours, are discerned with the aid of the nose. And here a beautiful adjustment presents itself for our admiration. The sense of smell is so delicate that it is very quickly dulled if treated ungently. A sweet smell inhaled too long ceases to please, and we get reconciled to the foulest

stench when we have endured it for a time. But when pleasant food is being crushed in the mouth, a gentle whiff of the odours that exhale from it is passed up to the nose for approval each time we breathe out, and then, when we draw in our breath, a current of pure and unscented air blows over the sensitive surface and rests and freshens it; so it retains its power of delicate perception and enjoyment all through a meal. When we wish to detect a very faint odour we get the same effect by taking several short whiffs in quick succession. A dog does this very noticeably when smelling for a rat, and it seems to me, though I have never seen it noticed, that a dog's nose is peculiarly constructed to increase this effect. His nostril is not round, but long and narrow, and there is a projecting flap over it, which he can depress, so as to reduce the opening to a very narrow slit and draw a thin stream of air over a broad surface.

The dog's nose

In the dog and some other animals the sense of smell reaches its climax, and has the ascendency over all the other senses. I feel sure that if we could dissect a dog's mind and bring its consciousness under a microscope, we should find that the picture of the world which it carries about in its imagination is not painted in forms and colours, but in odours. When it comes home with the family after a long absence, and

races the children down the avenue to greet the old familiar haunts, its joy is the same as theirs, but the wording of it, had the dog words, would be very different. It would not see the ivy-clothed gable looking between the trees, with the little curtained window of the nursery for its eye, smiling so familiarly, and the chimneys above, with the smoke curling up from them and saying, 'A warm fire waiting for you inside.' While the children are looking up and down and everywhere, seeing these and many other things, and shouting their joy or surprise or vexation, it is trotting along with its nose to the ground, stopping to sniff at each corner stone, recalling dear associations, sadly noting changes and missing familiar odours. As an idle man walks down a street, his eye ranges over signboards and door-plates and the costumes and faces of the people, gleaning trivial matter for the flow of his thoughts. The dog trotting beside him sees none of these things, but the breath of each shop that they pass suggests some train of thought. It observes that a big dog which it fears and detests has lately been calling at No. 18, recognises the dairyman's message boy by a pleasant flavour of milk, and notes that that schoolboy must have a bun secreted in his pocket. So it reads the air and deciphers the wind, and moves in a world into which we never enter. Yet it is not

barred against us. We have the keys, only they are rusty. Use would brighten them, and imagination cannot put a bound to the new experiences that would be opened to us. But the fact is, we cannot afford it. Our power of attention is strictly limited in quantity, and what we turn into one channel is drawn off from another. We are like a water-pipe with many taps; the flow depends on the gauge of the pipe. You will get the full force of it from one tap, perhaps from two; but if you turn on too many you will weaken them all, and the water will not rise to the upper stories of the house at all. So the beast that moves near the ground, hemmed in by tree trunks, shrubs, and walls, or goes abroad in the darkness of night, may turn all the current of its attention on the nerves of its nose; but man cannot afford to do so without neglecting messages from higher and fuller sources.

The limits of the sense of smell

For the sense of smell, miraculously acute and searching as it is, is very limited in its scope. It announces the presence of things and guesses their substance, but it can gain no knowledge of their forms, nor does it of itself discern their situation. By attention to the set of the wind, if there is any, a dog ascertains the general direction of any object which it smells, and then it proceeds as children do in the game called 'Hide the thimble.' The child at first goes

aimlessly about the room, looking for the hidden thimble, until the signal, 'warm,' from his companions lets him know that he is getting near it. He takes a wrong direction, but the word 'cold' warns him to turn back, and so at last he puzzles out the right place and lights upon the object of his search. If you send a dog to fetch something that you have hidden in the garden, you will see it play this game just like a child, its nose crying 'warm,' 'hot,' 'cold,' as it turns this way and that. It gives one an impressive sense of the limitations of the nose to watch a dog puzzling out in this way a thing which is lying close beside it and glaringly visible. On the other hand, the sense of smell beats both sight and hearing in some ways. The ear knows of nothing that is not moving, while sight is baffled by every wall or hedge, everything, in fact, except glass, which chances to lie in the way of a straight line drawn from the eye to the object. The sense of smell knows nothing of these limitations, and many things which are quite imperceptible to both eye and ear are instantly detected by the nose, as, for example, an escape of gas. Lastly, the nose not only discovers what is, but what has been. Now and then the other senses may chance on some evidence of the past which they can decipher. A warm place in my bed reveals to me the sad fact

that my trusty dog, which is fawning upon me with such effusive affection, and looking so innocent, jumped out of it not half a minute ago, when he heard my hand on the door handle; and footprints in the garden will show how the thief went round, trying the different windows. But scarcely anything in the world can move or stay without leaving tokens for the nose. And so it is that we are fain to call in the dog to search for a rat whose presence we suspect but cannot discover. Eyes are helpless because it is hiding, and ears because it is still; but the dog shows at once the very course it took as it ranged the room, and the cranny in which it is now skulking.

Considering these things, I think we may call back the simile of the water-pipe, and remember that pipes often leak and much water runs to waste, all the more so when the taps are all shut and there is no way by which it can run to usefulness. And there is such a thing as mental leakage, pure waste of attention. Indeed, it seems to me that there is scarcely any point in which the man who succeeds in life differs from the man who fails more than this. The one has his attention always active and, wherever he goes, is picking up something and storing it; whereas the other goes through life dreaming, as we say, which is pretty correct, for we dream when we are half asleep, that

is, when the senses are off duty. This is partly a difference in nature: some men have a power of continuous, restless attention, which has not been granted to others. But it is also partly a result of discipline and habit. We all recognise this when we speak of the importance of training children to use their eyes. But why only their eyes? If God has given men five senses, why neglect any of them? If we trained them all and used them all, not one in excess at the expense of another, but each in proportion to its helpfulness for right and useful ends, then we might save much attention which now runs to waste. For there is a time for everything under the sun, and many a time when the nose might be bringing to the mind offerings of knowledge or pleasure without supplanting either the eye or the ear.

CHAPTER IV

THE PLEASURES AND PAINS OF THE SENSE OF SMELL

IT is surely a clear mark of the higher nature of man that, though his sense of smell is so much less acute than that of a beast, and, practically so useless, he is able to find in the exercise of it æsthetically a delight of which they know comparatively little. I have seen no evidence that a dog can enjoy any odour for its own sake. All smells associated with dainties, such as cake and pudding, are sweet to him by reason of the association; so is the smell of a baker's shop pleasant to me, for I love buns and 'cookies' of all sorts. The scent of a certain suit of clothes that I usually wear when I go shooting throws him into transports of joy, but that is the same as the joy which I find in a letter bearing good news. There is nothing æsthetic in it; the letter itself may be a repulsive thing, a slovenly

Delight in sweet smells

scrawl written on dirty paper. He also takes delight, I am sorry to say, in rolling on the remains of a dead rat, or other putrid thing, and coming into the house redolent of an odour from which hot water and carbolic soap will scarcely purge him; but that is only evidence that he is by descent and nature a feeder on carrion. As a rule, scents that carry no association of food or other pleasure appear to be repugnant to him. The cat tribe is in this respect much above dogs. Tigers, lions, leopards and other cats, when they are given a chance of smelling lavender water, rose water, and other flower scents, exhibit a most fantastic delight, and we may safely infer that, when they are wandering in the jungle, they derive something of the same pleasure from wild flowers as we ourselves do. Many other animals exhibit a similar capacity for the æsthetic enjoyment of odours, but none so much as man. He is made happy by sweet smells as he is by soft music. He scents his clothes with them, pours them on his hair, rubs his body with them, and burns them in his house; nay, he offers them to his gods, feeling assured that heavenly beings must be pleased and propitiated by such an etherial delight. Of the things that smell sweet to us many are also pleasant to the taste, and association may have something to do with our enjoyment of them. Rose water, for

example, is much used in Eastern cookery, and even we put it into sweatmeats ; cinnamon is equally good for scenting soap and flavouring chocolate ; the smell of an orange or an apple cannot be dissociated from its taste. But many of the smells that delight us most cannot be placed in any relation to food. For examples take the fragrance that rises from the ground after a shower of rain on a hot day, the scent of a hayfield, and the smell of incense or musk. Therefore the delight these things afford us is not to be classed with such gratification as a baker's shop can offer. It springs from something in our nature which is higher than the animal appetites.

They become symbols

For this reason sweet smells have furnished all nations with symbols for the expression of the most etherial emotions of the soul, those connected with human love and divine worship. Our own poets are full of imagery like the following :—

> Go, lovely rose !
> Tell her, that wastes her time and me,
> That now she knows,
> When I resemble her to thee,
> How sweet and fair she seems to be.
>
> Tell me not of your starry eyes,
> Your lips that seem on roses fed.
>
> A breath that softer music speaks
> Than summer winds awooing flowers.

Persian poetry and romance revel in similar conceptions; but the most beautiful and exuberant imagery of this kind in all the world's literature is to be found in the 'Song of Songs':—

'His cheeks are as a bed of spices, as sweet flowers; his lips are like lilies dropping sweet-smelling myrrh.'

'How fair is thy love, my sister, my spouse! How much better is thy love than wine, and the smell of thine ointments than all spices!'

'A garden inclosed is my sister, my spouse.'

The Bible furnishes another example, which is more to our purpose than any formal poem, in the beautiful scene of the aged Isaac blessing his son, whom he could not see with his eyes, '"Come near and kiss me, my son." And he came near and kissed him; and he smelled the smell of his raiment, and blessed him and said, "See, the smell of my son is as the smell of a field which the Lord hath blessed."'

Their use in religion

The votaries of almost every form of religion that the world has known, except severe Protestantism, have made use of sweet smells in their approaches to the deity. The Hindoo burns sandalwood before his idols, and offers them the sweetest flowers he can find. The fire-worshipping Parsee throws sandalwood into the sacred fire. The Greeks and Romans used

incense in all their worship, and the practice has survived in the Roman Catholic church. It may be that the average heathen worshipper does not get much above the gross conception that the smoke of the burning incense, going up to heaven, will reach and please the gods; but we dare not say that the founders of these religions had no higher thought. At any rate, the symbol was adopted in the religion of the Hebrews, and worked out to fuller and sublimer meanings. They were commanded to prepare a sacred incense consisting of equal quantities of four precious ingredients, which was not to be imitated for purposes of private luxury on pain of death. A little of this was to be burned upon an altar of pure gold every morning, and when the high priest, once a year, entered within the veil, he was to carry a golden censer in his hand, filled with fire taken from the ever-burning altar, and throw a little incense on it, so that a fragrant cloud might rise and envelop the mercy-seat as he went in. What all this expressed to the mind of the pious Jew we may gather best from the use that he made of it in his speech. 'Let my prayer be set before Thee as incense,' says the Psalmist; and in the Apocalypse an angel stands at the altar, having a golden censer, and unto him is given 'much incense, that he should offer it with the prayers of saints.' St. Paul speaks

beautifully of the fragrance of an act of self-denying kindness done to himself as 'an odour of a sweet smell, a sacrifice acceptable, wellpleasing toward God' (Phil. iv. 18); and in another place (2 Cor. ii. 15) he says that the lives of himself and his companions are 'unto God a sweet savour of Christ.'

The fragrance of incense filling a hall of worship has, of course, its direct effect upon the worshippers too, joining hands with music and architectural magnificence to elevate all their sentiments for the time. At the Protestant reformation all these sensual aids were swept away, and a temple was raised to naked spirituality. And there was need. It was a case of plucking out the right eye that offended. But the man who can keep both eyes without offence is better off. Professor Wilson, the author of 'The Five Gateways of Knowledge,' has some quaint remarks on this subject, picturing the surprise with which a stranger, entering our churches, would observe that, of all our five senses, we admitted only one, the sense of hearing, to our worship. He might have added that the chief exercise in which that sense is engaged might sometimes appear to the stranger to be penance. It is a pity. True worship is of the spirit; but as long as we are in the body the senses will all have their influence on the spirit, and a man who is

perfect and complete, wanting nothing, may surely call upon them all to join in his worship.

Fragrant memories

Another evidence that the pleasures of the sense of smell touch the higher regions of our nature and blend and harmonise with our deepest emotions, like music, lies in their peculiar power over the memory. As a simple song, or tune, heard after many years, will call back the past and bring tears to the eyes, so the fragrance of some wild flower that we used to gather in our childhood, or the odour of something stowed away for years in a forgotten drawer, will open again a long-closed chapter of our past life and call back

> The tender grace of a day that is dead

with a vividness and power that are quite mysterious.

Professor Wilson speculates, in the book above-mentioned, on the callousness of Western nations about sweet smells in comparison with Asiatics, and finds two reasons for it. One is, that aromatic substances give forth their fragrance far more freely in a hot than in a cold climate; in other words, that the Asiatic has more sweet smells to enjoy than we have. The other is, that the senses of the inhabitants of sunny climes are more acute and more capable of enjoyment than ours. Now

I think that this second reason involves a very common, but very serious, error. Granting that the senses of Asiatics are sharper than ours, which is very doubtful, the mere acuteness of a sense is quite a distinct thing from the kind of discernment which opens to us its higher pleasures. The dog has shown us this already. The fact is that the sense of smell is distinctly in a higher state of culture among the civilised nations of the West than among Asiatics, and the best evidence of this is just the fact that the latter are able to revel in strong smells in a way that is impossible to us. The favourite flowers of the natives of India are almost all too heavy-scented to be long endurable to a European. It is the principle of the curry-comb again, which I said would prove useful. The flowers that Asiatics love are sweet—unquestionably sweet—and in the open air we recognise it; but we could not go about with garlands of them round our necks and chaplets of them on our heads, because they irritate our sensitive perceptions too strongly. This brings us to the pains of the sense of smell.

The culture of the sense of smell

In connection with the sense of touch I noticed that pleasure is a gentle degree of pain, and pain is the too great violence of pleasure. The sense of smell furnishes many illustrations of the same thing. Scarcely any scent

The offence of the sense of smell

is more esteemed in the East than musk. Princes and great men scent their notepaper with it, and other things which they use, so that to an old Anglo-Indian the odour of musk involuntarily calls up visions of jewelled rajahs, and durbars, and barbaric splendour. We are not quite so fond of it as Asiatics, but I believe that we import about 10,000 oz. of it per annum, paying as much as 3*l.* 10*s.* per oz. for the best quality. Now this musk is a substance given by nature to an Indian species of deer for a defence against its enemies; and before age and exposure have softened its pungency it is so horribly offensive that musk-hunters are said sometimes to suffer from bleeding of the nose when engaged in cutting the musk-bag from the dead animal. Another example of the same thing is asafœtida. The natives of India revel in the smell of it, and use it in cookery, calling it *hing*; but to us it is always *asa fœtida*, a fetid thing, the odour of which is almost unique for oppressive loathsomeness. Yet there is scarcely an Englishman in India who does not relish the crisp wafer biscuits, known as *papree*, which are commonly served with curry, before he learns that their pleasant, aromatic flavour is due to a minute quantity of asafœtida. We cannot trace the same principle in all the things that are offensive to the nose: there are many smells which we naturally

dislike without being able to find any satisfactory reason for it. But this is a defect of knowledge. There is a reason for everything, which we must hope to discover as our knowledge grows wider and truer. In the meantime there is one thing that we can lay hold of, which declares itself plainly enough, in spite of exceptions and apparent contradictions, namely, that decay and putrefaction are offensive to the nose. The sense of smell, taking knowledge not of the outward forms of things, but of their substance, is the one sense by which we perceive and shrink from corruption and everything associated with it, to wit, dirt and festering foulness of every kind. By its interpretations, too, are disease and death and the grave made repulsive to us, and not only so, but it is in the language of this sense that we express to our own minds the moral repulsiveness of whatever is foul in thought, speech, or conduct; for, as Darwin has pointed out, when we think of anything base or vile in a man's behaviour, the expression of the face is 'the same as if we smelled a bad smell.'

CHAPTER V

THE SENSE OF HEARING

IF a stone is thrown into the middle of a pond a ring-wave starts from the point at which the stone sank, and, expanding, travels in every direction outwards till it reaches the banks of the pond; or, if the pond is a large one, it may seem to die away before it gets to the bank, for it diminishes as it expands at a regular rate proportional to the square of the distance. The motion of the wave is a peculiar thing, which we must understand before we can understand rightly anything about sound, or light either, and we must know something about sound and light before we can think intelligently about the working of our eyes or ears. The peculiarity of wave-motion is that, though the wave travels, the water does not: no part of the water in the centre of the pond goes to the bank. What happens is this: the water which the stone elbowed aside as it sank makes room for itself by giving a

Undulations in the air

shove to the water next it, which in turn gives a shove to the next, and so on; thus the motion we see as a wave is passed on, while each particle of water remains where it was, or nearly so. If this is not severely scientific I hope it is plain, and I think it is sufficiently accurate. But a better illustration of the true nature of wave-motion may be seen in any railway yard when shunting is going on. An engine comes slowly up to one end of a long train of waggons and bumps against it and stops, and immediately the bump is passed on from waggon to waggon down the entire length of the train, but the train as whole does not move from its place. This happens because the waggons have spring buffers. The springs of the first waggon are compressed by the sudden impact of the engine, but they expand again, and, in doing so, pass on the impulse to the next waggon, whose springs in turn first yield and then recover themselves at the expense of the third, and so on. And it is because of the elasticity of all fluids that any sudden impulse given to them starts a wave-motion or 'undulation,' which is the same thing put into Latin. Water is indeed, strictly speaking, almost inelastic; but what we see on the free surface, where it forms a raised wave, takes place in a modified way down in the depths; and, of course, the same thing happens in air quite freely, for air is exceed-

ingly elastic. When the head of a nail is smartly struck with a hammer, both the nail and the hammer suffer a violent jar, which imparts a concussion to the surrounding air very like the effect of dropping a stone into water, and this starts a wave-motion in all directions through the surrounding air at a rate of which the water wave will give us no conception. A concussion of this kind, if very violent, may break the windowpanes, and a more gentle one might jar the delicate wings of a butterfly; so it is quite conceivable that, without ears or substitutes therefor, a fragile insect may be sensitive to the motions of the air which we call sounds. But intimations received in this general way would be too vague to be useful. They would only show that the air had been jarred somewhere by something. There can be no doubt that not only insects, but creatures of lower rank, have special organs for perceiving something more than this, for analysing, in short, the force, nature, and direction of the concussion, and so guessing what may have caused it. The sounds made by many different families of insects—for example, the buzzing of bees, varying with their different humours, the chirping of crickets, and the screaming of cicadas—would be a strange enigma if we did not assume that they have a sense of hearing. This may be lodged in organs

The beginnings of the ear

very different from our ears. A delicate bristle, with a fine nerve-fibre at the root of it, might answer to the most gentle vibrations of the air and communicate them to the brain; a thin elastic plate, or a thin membrane tensely stretched, might do the same. And many such organs have been discovered about the antennæ, legs, and other parts of insects and shellfish, which may serve that purpose; but it is no easy matter to get certainly at the use of any part of the minutely intricate life-machinery of a creature whose whole body is constructed on a plan totally different from our own. And it is still more difficult to get any idea of the sensations which may be conveyed to such a creature, even by those organs of sense which seem to correspond in their purpose with our own. We can only judge of what goes on in the consciousness of another being from what we feel going on within ourselves, and how lamentably does this mislead us sometimes even in judging one another! How much further wrong may we go when we try to interpret the consciousness of an insect by our own? Take, for example, a cricket. Here is an animate being, placed in the world along with us, with a life to maintain, wants to satisfy, desires to gratify, and pains and dangers to avoid. Its equipment is in some degree like our own. We

What a cricket hears

have legs, that we may change our place as circumstances may require, and so has it, but it has six of them. We have ears to help us to keep in touch with the world. They do not hear all possible sounds. A musical note of less than 16 or more than 50,000 vibrations per second is not distinct to our ears, and many sounds within that range are not loud enough to be audible. But the powers we have are sufficient, and suited to the conditions of our life. The cricket also has ears, but they are on its legs. They are very unlike ours in their construction, and we have no reason to suppose that they are similar in their range or powers; indeed, we may almost assume that they are as different as the conditions of the cricket's life are. It lives on the ground, under stones, and takes its walks among tangled forests of grass and weeds, or gloomy labyrinths of fallen leaves. The shrieking of a railway train or the firing of a gun has no concern for it, and it does not appear to discern such noises, at least it gives no heed to them, unless they are near enough to cause a disastrous concussion of the air. But need we doubt that the air is as full of the sounds of life to it as a busy street is to us? As it threads its perilous way among centipede-haunted wilds, exploring the path with its long antennæ, it hears, with mingled feelings, the martial tramp of an

army of ants, the peaceful browsing of caterpillars, the rustle of earth-worms cautiously drawing dead leaves into their holes, and the music which the wind makes with the tender spikes of growing grass, that rise, like telegraph posts, all about it. And it hears the voices of its own kind, the chirping of fellow crickets. Then it knows that it is not alone: it chirps in reply, and enjoys the cheerful pleasures of social intercourse.

Among the vertebrate animals the hearing organ is always in the head. Fishes and reptiles have no outward ear, and generally no opening to the outer air at all, and their sense of hearing is no doubt dull, though by no means so useless as has commonly been taken for granted. Birds have no outward ears, but I know that they are very sharp at catching the call of their own kind or the voice of a hawk. Still, as I have already observed, birds live more by sight than any other sense. It is in beasts and man that the ear is found in its perfection. Some beasts hear far more sharply than man, but this does not imply that the sense is more highly developed in them. Our range and our power of discerning fine distinctions of tone may be, and probably are, far superior to theirs. At any rate, we may safely take the human ear as embodying all the 'latest improvements,' and stop at this point

The human ear

to examine its construction. First, there is the outer ear, which is only a sort of windsail to catch the movements of the air, very curiously shaped on some principle which I do not believe we fully understand. In the hare, deers and many other animals, this is improved by enlarging it and making it movable, so that it can be turned in any direction, enabling the animal to judge better from what point a sound proceeds. That our ears were originally planned to move appears plainly from the fact that muscles for moving them are present, and I have a friend who will wag his ear at you on occasion with fine sarcastic effect; but in most of us this power has been lost by disuse, being unnecessary. I believe, however, that anybody who wished to recover it could do so by perseveringly turning his attention on his ears for a time every day, and strongly 'willing' to move them. From the centre of the outward ear a winding passage goes into the head for a short distance, at the end of which it is completely closed by a tightly drawn membrane called the *tympanum*, or drum. We can readily understand that the tympanum, like the similar membrane which we put into the bell of a telephone, will vibrate in response to every vibration of the air. But that alone would be of little use. The vibrations must be interpreted, or converted into those

sensations of the brain which we call sounds, before they can have any meaning for us. And for this purpose it is necessary that the auditory nerve, which the brain sends down to the ear, should be affected in a different way by every different kind of vibration. For there is as much variety in the vibrations of the air as in the waves of water. The vibrations produced by a shrill note from a flute are as different from those that proceed from the bass pipes of an organ as the ripple produced on the surface of a pond by a crisp breeze is different from the swell on the ocean after a storm. And unless the ear nerve takes up these differences pretty accurately, its messages will be of little service. The machinery by which it is enabled to do this is most marvellous in the intricacy of its design and the delicacy of its workmanship. I will not attempt to describe it scientifically, being persuaded that very little understanding of such things is to be gathered from any description; but if I can give a general idea of the plan of this hearing apparatus, it may be helpful. Have patience with me if I fail.

In the first place, there is a cavity at the back of the tympanum, called the 'tympanic cavity,' filled only with air, and behind that, buried in the bones of the skull, there is a closed box containing a fluid. The latter is called the 'labyrinth' from

its very peculiar shape. One side of it is like the shell of a snail, while the other side consists of three semicircular tubes. Why it should have this curious shape we cannot tell. In two places in the bony walls of this box there are holes with membranes stretched across them, like the tympanic membrane. One of these membranes is connected with the tympanum by a chain of three small bones, which, from their grotesque shapes, have been named the 'hammer,' the 'anvil,' and the 'stirrup.' This chain stretches across the tympanic cavity. The hammer bone at one end is firmly attached to the tympanum, or drum, and the stirrup at the other is attached to the membrane which closes one of the two holes in the side of the labyrinth. So, when the drum is thrown into vibration by any concussion of the air, that vibration will be passed along the chain of three bones to the membrane of the labyrinth, and a thrill will pass through the fluid with which the labyrinth is filled. Now there is on the inside of one part of the labyrinth an extraordinary piece of work, known as the 'organs of Corti,' consisting of about 4,000 minute arches, of very complicated form, and regularly graduated in length and height, which suggest the chords of a piano to every writer who tries to describe them.

Its internal construction

An instrument of many strings

Everyone knows that, if you sound a note with the voice or any instrument, within hearing of a piano, the piano will answer, because the chord in the piano that corresponds to the note you have sounded will be thrown into sympathetic vibrations; and it almost suggests itself that, in the same way, every tone which enters the human ear may awaken a response in one or other of the organs of Corti. Anatomy shows that the auditory nerve from the brain enters the labyrinth and there breaks up into fine fibres, which lose themselves, or rather, which we lose, in the neighbourhood of the organs of Corti; and if we suppose that a separate fibre is supplied to each of these organs, then we may infer that, whenever any one of them is set in motion, it sends its own distinct message to the brain, for though the fibres unite to form a grand trunk nerve, they do not coalesce; each fibre is as perfectly isolated from the rest throughout its entire length as the separate wires in a telegraph cable. So, according to this supposition, the brain would have 4,000 instruments ready at all times to receive and transmit 4,000 different tones. But this is not enough. The number of audible tones is very much more than 4,000. The notes commonly used in music range over about six octaves. Of course there are audible notes both above and below this, but the ear loses

sensitiveness so rapidly towards the extreme ends of its range that we may neglect these at present. Taking six octaves, then, as the range of the human ear, we have 72 semitones in that range, and it is a well-known fact that a good musician, tuning a violin, will distinguish a difference of $\frac{1}{64}$ of a semitone. But this is the limit of his skill to separate and distinguish, not of his ability to hear. By methods which I cannot detail here it has been satisfactorily established that, in the compass of a single semitone, there are, on an average, 153 shades of sound which the ear can hear. Multiplying 153 by 72, we get, in round numbers, 11,000 separate tones audible to the ear. So scientific men have had to look elsewhere than to the organs of Corti for the instruments that pick up these tones. They are an important part of the framework, no doubt, but wonderful as they are, we must find something more wonderful still before we can account for the marvellous powers of the ear. And there is something. The membrane to which the arches of Corti are attached consists of innumerable parallel fibres. I have said innumerable, but that is only to be understood in a figurative sense. The fibres, or chords, of this wonderful harp have been successfully counted, and found to number about 24,000. Again, there are, in connection with the arches of

Corti, curious cells, with fine, hair-like prolongations, which are said to number 15,237. Now, the separate fibres in the auditory nerve come to about 14,000 in number. Each of these, we may safely assume, has a terminal receiving instrument somewhere, and though we cannot yet tell whether it is in the parallel chords of that harp to which the arches of Corti are joined, or in those curious hair-cells with which the whole apparatus is so thickly studded, it is plain that in either case we have a telephonic instrument sufficient to account for what we have found that the ear is actually able to do.

The mystery of the ear

There is a good deal of 'supposed,' and 'inferred' in all this; but it will be some time before we get beyond the need of those words in this subject. We have invented no means yet of watching a living ear at work. All we can do is to look into the mechanism of a dead ear, as far as our microscopes will take us, and to guess at ways in which the various parts may work together towards the end which our consciousness tells us is gained. And perhaps the most valuable thing we can carry away from our search is a fuller meaning for that text, 'I am fearfully and wonderfully made; marvellous are Thy works, and that my soul knoweth right well.' At first it almost astounds us to find such elaborate

intricacy of design and workmanship expended on a little organ which exists merely that we may be able to hear sounds. But when we consider the matter rightly it is not strange. It would indeed be strange if the stomach, with all its auxiliary organs for converting the flesh of beasts and fowls and fishes, and the fruits of the field and the garden, into human blood ; and the heart, without a moment's respite by night or day, pumping that blood into a network of veins that it may visit every corner of the body and build up bone and muscle ; and the lungs heaving ceaselessly to freshen that blood with pure air ; and a score of glands and other organs assisting in one way or another—it would be passing strange if all these were working together to maintain on the face of the earth an idol made of bones and flesh instead of stone. But this body of ours,

> This breathing house not built with hands,

is not an idol, but a mysterious thing by which a soul holds a place in a world of matter and enters into relationships with it. And the senses are the passages by which communication is established between it and the other existences in that world, the bridges without which it were a solitary island, self-contained and unvisited. No wonder if it seems as though more attention had been

paid to their construction than to all the rest of the body, for they are the end and object of all: limbs and members, alimentary system, and everything else is subservient merely. But let us pass on.

All sounds spring from life and motion; silence is the attribute of stillness and death. And it is into a world of life and motion that the soul is launched with this wonderful sound-hearing instrument. He knows nothing; everything about him is new and mysterious, even his own faculty; but there is in him an almost infinite capacity to learn, and he begins at once. A sound! What and whence was that? It struck both ears, but one more strongly than the other. He must distinguish between the impressions, and then he will discover, by many experiments, that the sound is from that side on which it was felt most strongly. This lesson takes an infant many weeks to learn; but when once it has been learned, the attention and the other senses turn instantly to the quarter from which any sound assails the ears, until, by accumulated and compared experiences, the sound is surely linked with something which happens simultaneously, as cause and effect. But exercise in judging directions goes on long after infancy, for it is a difficult art, requiring much practice and

Learning the use of the ear

fine perceptions; and proficiency in it is rare. The sound sensation itself is another study. The instrument is there, with its four thousand strings, but to master it is the work of a lifetime. Few master it but great musicians, if even they. Most of us are content with a measure of proficiency which we consider sufficient for practical purposes. Be it remembered that very few of the noises that we hear are pure tones, or even simple sounds, but blends of many sounds, concordant or discordant. When you tear a sheet of paper there is a fusillade of small musketry, each fibre as it snaps making a separate report. The murmuring of a mountain stream is the noise of a battle in which the warriors are a million of wavelets, now striking the pebbles, now falling back and striking one another, and rising again and wrestling and struggling, with blow upon blow, and clash upon clash. We cannot analyse all noises, but we hear the combined effect and know it when we hear it again. And what an almost infinite diversity of sounds the stupidest man among us has learned to distinguish and recognise. And when we consider the wild beasts and the birds, what a variety of elemental movements and activities of life must be known to them chiefly through the sounds to which they give birth.

In the beginning this faculty is applied to the recognition of those things that concern the needs of life, or its perils, for that is not first which is spiritual, but that which is natural. And marvellous good service it does. The velvet footpads of the tiger, and the soft, noiseless wings of the owl, are unsolicited testimonials to the alertness of those sentinels that stand on guard night and day against their attacks. And, indeed, many animals, especially those that walk by night, commit the custody of their lives almost entirely to the senses of hearing and smell, putting little trust in sight. The ears have this disadvantage, that they can discover only motion. Of a silent enemy lying in ambush by the way they can give no warning, as the sense of smell may. On the other hand, the nose is easily foiled by the wind, and without wind it has no knowledge of directions. So the two supplement each other, and such is their acuteness, such their ceaseless watchfulness, that the tiger, for all his velvet footpads, must tune up every sense and practice every art for which his lithe and supple form fits him, must tread as if on broken glass, and crouch and trail his body over the ground, as if he were a snail or a slug, instead of a king of beasts, and make long *détours*, and lie in wait at strategic points, and bide his time with

Practical purposes first

invincible patience, or he will never dine on the *sambhur* stag.

Expanding interests.

But as the mind expands and interests widen, other sounds will become meaningful to the ear than those that tell of food or peril. A tropical forest is full of sounds. 'The winds that will be howling at all hours,' the groaning of strong boughs rubbed against each other by the storm, the falling of ripe fruits, the gurgling of streams, the rustle of leafy boughs shaken by monkeys, the cries of birds, the shrill scream of the cicada—these, and many more, go on all day, the interest of them depending on the ear that they fall upon. To the all-exploring mind of Diogenes Teufelsdroch it was 'impressive enough to hear in early morning the swineherd's horn, and know that so many hungry, happy quadrupeds were, on all sides, starting in hot haste to join him for breakfast on the heath.' But to the average hind of Entepfuhl there was, I daresay, little impressiveness in that sound. So it may be (we know not) that the sounds of the forest are almost unheard, and altogether unheeded, by the grosser beasts; but many birds certainly do notice them, for they amuse themselves by imitating them. Mimicry is far commoner among wild birds than is commonly known. Moreover, passing sounds are, in some mysterious way, worked into the

web which the brain is weaving when they fall upon the ear, so that, when heard again, a long while after, they will call up the very mind we were in when we first heard them, and joys and sorrows, which seemed to be dead and buried for ever, will wake to life and pass before us again with vivid clearness. So it is that an old song, a wild cry, or the groaning of a water-wheel, will sink into the brain like a seed into the ground, and after many days spring up again in desert places, and blossom into those memories of past happiness which are among the sweetest things that our earthly life has to offer us. When Campbell's war-worn soldier wandered in his dream to his beloved home among the hills, he

> Heard his own mountain goats bleating aloft,
> And knew the sweet strain that the corn reapers sung,

because those sounds were inseparably woven into all the happy life that he had lived there 'in life's morning march.' So Wordsworth says to the cuckoo:

> And I can listen to thee yet,
> Can lie upon the plain
> And listen till I do beget
> That golden time again.

We need not assume that the beasts and the birds know nothing of the joys that spring from such associations. I do not believe that their lives are

so barren. As the seeming-listless old sheep grazes in the field, the song of the sky-lark poured over it from the blue heavens above does surely call up, in some dim way at least, pleasant visions of that first spring-time when it was a joyful, bounding lamb, and all the world was new and bright and the lark was singing in the sky.

The sound of social life

Lastly, there is one class of sounds which have an interest for every living thing that can hear at all. I mean the voices of their own kind, and not the voices only, but all the sounds that indicate what they are doing—the flapping of wings in the air, the cracking of twigs and leaves under foot, the noise made by a rabbit when it burrows, a woodpecker when it taps, and by sheep and cattle when they graze. To those animals especially, which are gregarious and sociable in their habits, these sounds are of much import, telling them always what their neighbours are doing, and so making them participators by interest and sympathy in the whole life of the community to which they belong. Have not we—grown too voracious to be satisfied with such knowledge as the noises of the street can supply—devised for ourselves in the newspaper a great, world-embracing, machinery for feeding just that same craving for a share in the general life of our species? But the newspaper can never supplant

those common sounds by which we have constant and immediate intelligence of the life that goes on in our own houses and about our doors. Can 'Morning Posts' or 'Evening Couriers' give us the rattle of cab wheels, the dog's bark, the tinkle of the door bell, the opening of the door, the footfall on the stair? For this reason deafness is a more grievous calamity than blindness or almost any other evil that can befall us, shutting us out from the movement of that portion of the great stream of human life with which our own is mingled, and dooming us to seclusion in full view of society.

But let us return for a little to the voice, for it is more, in every way, than all other noises of any sort that a fellow-creature can make, inasmuch as it opens to the perceiving ear a door into a new region, into the very chambers of the soul. Every animal that has a voice at all utters at times sounds, voluntary or involuntary, under the pressure of various emotions or passions, and by these tokens comes the possibility of knowing, not merely the whereabouts and outward activities of its body, but the inward state and motions of its mind. This is the birth of fellowship and communion, when two creatures, each perceiving that the other feels as it feels, become 'fellow-creatures,' saying within themselves, 'This is my brother.' At first simple and almost wholly unconscious, but always beautiful,

this bond grows ever stronger as perception grows fuller, enriching life. Most gregarious birds, I have observed, keep up a continual quiet chirping, or chattering, when they are going about together in search of food, which, perhaps, expresses nothing but a vacant mind, like the prattle of a child at play, but serves to keep the flock together. It is, in fact, a token that life is going on in the normal way, in security and contentment, and each member of the flock, hearing it, knows that the rest are near and that all is well with them. Other notes tell of alarm, pain, or pleasure, and these, too, are understood by all birds of the same species (for they make the same sounds themselves when alarmed, pained, or pleased), and even by birds of other kinds, where there is any community of interest or feeling, as there often is, for much neighbourliness exists among little birds of different species. For example, in India there are two common birds, the bulbul and myna, which utter a peculiar, sharp cry at the sight of a hawk, and sometimes, when wandering in the jungle, I have heard it and astonished my native attendant by telling him suddenly that there was a hawk somewhere overhead. He plumed himself on his woodcraft, but was obliged to admit that he did not see it, to which I would reply, 'Nor do I; but the birds say so.' Presently the hawk came in sight, and he turned

and looked at me doubtfully, as if he feared something uncanny. But every little bird in the trees about us had understood the cry of the bulbul as well as I had, and was already in a place of safety. There is quite a different note, a kind of continued twitter, by which the bulbul announces the appearance of a prowling enemy, from which it is not necessary to fly helter-skelter into cover, but which must be watched, or mobbed, until it leaves the neighbourhood, such as a cat, or mongoose, or snake. The myna greets an enemy of this kind with a loud, harsh note, repeated several times, and either of these signals will at once bring together a mob of small birds. Again, who does not know the peculiar cawing of a crow when it sees one of its own kind lying on the ground, dead or wounded? It acts like the cry of 'house on fire' in a town. It is taken up by every crow that hears it, and soon the whole population is hovering over the victim of the accident, cawing vociferously. But no other bird heeds this cry, because it always announces an accident *to a crow*.

Speech

From all this it is a short and simple step to speech. For if I see that my neighbour knows my mind by the sounds I make, I will make sounds that he may know my mind. When a chicken wanders and loses its mother, a horror of loneliness seizes upon it, and it cheeps aloud,

as an infant cries when it feels neglected and hungry. The hen hears, understands, and runs to the help of her offspring. Is it rating the intelligence of a chicken too high to say that, another time, when it is in trouble, it will cheep *that its mother may hear and run to its help*? Indeed, I do not see how any-

The conversation of birds and beasts

one can watch a hen with her brood and doubt that many of the sounds which they make are distinctly addressed to each other with the knowledge that they will be understood. And who can watch a pair of crows about their nest without seeing that they are expressing sentiments and desires to each other? I am not a crow, but I can often tell how a crow feels, and what it is about, by the tone of its caw. So could Virgil, or the Greek poet whose thoughts he stole, if we may judge by that beautiful passage:

> Tum liquidas corvi presso ter gutture voces
> Aut quater ingeminant, et sæpe cubilibus altis,
> Nescio qua præter solitum dulcedine læti,
> Inter se in foliis strepitant: juvat imbribus actis
> Progeniem parvam dulcesque revisere nidos.

And we may take it for granted that a crow is likely to be better understood by its own wife and children than by Virgil or me. Birds differ widely in intelligence, but many others besides crows, for instance, parrots, starlings and many gregarious tropical thrushes, appear to me to be constantly

holding converse with one another as they feed or go about their other avocations. In this respect birds, with their acute observation, talent for mimicry, and vivacious loquacity, seem to be far in advance of beasts generally. What may be the compass of their language, and to what definiteness and variety of terms they may have attained, our utter ignorance of their home life makes it unsafe even to conjecture. Our study of natural history up to this time has consisted so largely of killing our fellow-creatures, to flay them, cut them up and give them names, that, instead of drawing them nearer to us, it has driven them as far from us as they can get. My own impression is that the language of birds expresses feelings and desires rather than facts or opinions. Its parts of speech are two, namely, the interjection and the verb, which latter has one mood, the imperative. Reflect how largely the talk of little children is made up of these two. And in spite of the Max Müller of monkey philology, I question very much whether monkeys have got any further. It would have been extremely interesting, and to thorough-going evolutionists highly satisfactory, if Professor Garner had succeeded in spanning by his 'bridge of speech' that obstinate gulf which yawns between us and our hairy progenitors; but I am afraid he must find more substantial materials before his

bridge will 'bear.' The gulf yawns still, and I am inclined to think that the noun or name, the sound-symbol of a *thing*, will be found on our side of it only. This I take to be an invention, something totally distinct from the exclamation of emotion, which comes of physical causes, like the wagging of a tail or the brandishing of limbs under excitement. As to how it came about, whether it was stumbled on by accident or grew imperceptibly out of the exigences of life, or was devised by some master mind, we may hold what theory we please. It came about 'and Adam gave names to the fowl of the air and to every beast of the field.' The verb (sound-symbol of action seen in things outside or performed by myself) could not but follow quickly, then the adjective and the adverb, and so on, until the wonderful apparatus was complete, and man could spread out the workings of his mind, when he pleased, to the perceiving ear of his fellow-man. And the greater, farther-seeing, mind could offer what he had gathered to those less gifted than himself, in such a form that they could receive it, just as the old bee stores the honey it has found among the flowers, that the young bees may feed which are not able to find for themselves. So, by one slender nerve and an instrument at the end of it, devised to measure the vibrations of the material

The language of man

air, I reach into a region beyond and above all matter, and glean the thoughts of the human mind and the feelings of the human heart over all the world. It signifies little that the written record often takes the place of the spoken word and the eye seems to set aside the ear. The eye never really sets aside the ear. Written characters are marks standing for sounds, and have no meaning till they are turned into sounds by the mind ; then we hear them in imagination and understand them. No one thinks in writing, unless it be a deaf man who has learned his language through his eyes alone. Even when we try to learn a foreign language by grammar and dictionary, without a teacher, we always frame to ourselves some pronunciation for each word, that it may be a word to us and not a mark only.

CHAPTER VI

THE PLEASURES OF HEARING.—MUSIC

When Jubal struck the chorded shell,
  His listening brethren stood around
And, wondering, on their faces fell
  To worship that celestial sound.
Less than a god they thought there could not dwell
Within the hollow of that shell
That spoke so sweetly and so well.

NOTE (for it is worth noting) that they did not reason about it. They had no theory of music, no explanation of its effect on them, nor any evidence that its influence was of an elevating and ennobling tendency. They simply *felt* its power and succumbed. And from that day the ear has, by universal consent, held the highest place among the senses as the minister of a pure and noble delight. The indulgence of every other sense has at times been outcasted by religion or fashion, but the zealot who would ban music could find no followers. The Puritan, who would not minister to

the lust of the eye by worshipping in a graceful building, sang psalms in his worship, and the heaven he hoped for was a place where

> . . . the cherubic host in thousand quires
> Touch their immortal harps of golden wires,
> With those just spirits that wear victorious palms,
> Hymns devout and holy psalms
> Singing everlastingly.

Music has, indeed, been pressed into the service of religion in all countries and at all times. It has been a power in love and war, and an indispensable element in all social and public rejoicing. Its mysterious potency has been relied on to expel malign spirits and subdue venomous reptiles, and its power over savage beasts has been expressed in myths which, at one time, were accepted as veracious histories. And so they were, if veracity is to be tested, not by the dictionary meaning of the words used, but by the idea which they will convey to the minds for which they were intended. To a simple people, inoculated from infancy with the marvellous, how could such effects as those produced by Mr. C. J. Cornish on the animals at the Zoological Gardens be adequately conveyed except by stories like those which the Greeks told about Orpheus?

The effects of music on animals

Mr. Cornish experimented, first with a violin and then with a flute and piccolo, upon monkeys, lions,

tigers, bears, wolves, deer, zebras, wild cattle, boars, elephants, snakes, scorpions and other animals, and the results were very remarkable. The piccolo angered some and pleased none; the flute charmed many; but the violin produced the most striking effects. Deer, cattle, the wild boar, the tapir and the wild cats left their beds, and, drawing near, stood all ears. Some rose on their hind legs and rested their forefeet on the railings of their enclosure. The polar bear reared up and, spreading out his forearms, pushed his nose through the bars of his cage. Others walked up and down in great excitement. The young orang-outang turned heels over head, and then, sitting on the ground, chucked handfuls of straw into the air, 'smiling with delight and approval.' The flute set the Indian wild asses 'kicking with excitement.' A tiger was charmed with the violin, thrown into a fury with the piccolo, and again soothed with the flute. As a rule soft low music and minor keys gave most pleasure. Shrill and harsh tones unmistakably irritated most of the animals, while a sharp discord invariably caused them to start back as if they had received a shock. It was the sound of a bagpipe imitated on the violin that entranced the orang-outang, a fact that suggests some interesting speculations; which might, however, be regarded as invidious by my fellow Scots, for

which reason I will pass by them. One very remarkable fact is that none of the music pleased the wolves and jackals : it threw them into a state of rage or nervous terror, and, in the case of the Demerara fox, Mr. Cornish had to desist at the request of a keeper, who was afraid that the animal might have a fit. It has long been popularly known that wolves were averse to music ; but, as far as I am aware, no explanation of the fact has been offered, except the doubtful one, that their musical sense is distorted by kind Nature to enable them to endure their own howling. The whole subject requires investigation ; Professor Garner might take it up. Everybody knows how painfully many dogs are affected by music.

Another curious and unexpected fact, worthy to be ranked as a scientific discovery, was that snakes and lizards, and even scorpions, were strongly affected by the violin. The serpent charmers of the East have always professed to allure and control snakes by music, but we men of science have scoffed at them, and unmasked their pretensions by dissecting the ears of snakes, and showing that they could not possibly be of any practical use. Alas ! no sooner did Mr. Cornish's violinist begin to scrape in the snake-house at the Zoo, than the cobra, which was lying coiled up at the bottom of its cage, 'raised its head and fixed

its bright yellow eye with a set gaze on the little door at the back,' behind which, quite out of sight, the musician was performing. When the music became louder it raised itself and spread its hood, slowly oscillating from one side to the other as the violin played waltz time. 'The slightest change in the volume or character of the music was met by an instantaneous change in the movements or poise of the snake.' 'A rattlesnake in the next cage was also listening intently at the same time, with its head drawn back, and slowly rising and falling. But it was less apparently sensitive than the cobra. The violin suddenly reproduced the sound of the bagpipes, which greatly excited the snake, and as the "drone" was put on to the tune of "The Keel Row," its hood expanded to its utmost dimensions. Soft, minor chords were then played, and a sudden sharp discord struck without warning. The snake flinched whenever this was done, as if it had been struck.' I have never been altogether a believer in the supposed uselessness of the snake's ear, but I confess that these results surprised me.

The effect of the music on scorpions was, however, still more startling. A number of them were lying in 'their usual, semi-slumbrous state,' when the violinist began to play gentle and melodious chords, and gradually rose to a sustained series of

piercing notes. 'In a few moments, one after another, the creatures began to move, the mass became violently agitated, and the torpid scorpions awoke into a writhing tangle of legs and claws and stings. When the sounds ceased they became still.' We know very little about the organs with which a scorpion hears, and have no reason to suppose that they are constructed on at all the same plan as our ears. From what we know of their lives we might infer that they have little need for a sense of hearing at all. And yet

> Sharp violins proclaim
> Their jealous pangs and desperation,
> Fury, frantic indignation,
> Depth of pains and height of passion

to these cold-blooded creatures with as rousing effect as to ourselves.

The ear for music

Mr. Cornish found that different animals were susceptible in very different degrees to the charms of music, and while we may almost take it for granted that the genus Homo as a whole has that susceptibility more highly than any other genus of animals, we know that individual men differ very widely from one another in that respect. One man has what we call a 'fine ear,' while another takes little pleasure in sweet sounds, and cannot tell whether the simplest tune is played correctly. And this is not because the latter is

duller of hearing than the former. The musician may be as deaf as Beethoven, while

> The man that hath no music in himself,
> Nor is not moved with concord of sweet sounds,

may have ears as sharp as those of a hare. The 'ear' for music is a distinct thing, and the man who is without it is cut off from all participation in something which affords entrancing delights (and poignant pangs too), to those who are endowed with it. What is that something? Happily we can answer that question. The pleasures of touch, taste and smell, are yet wrapped in much mystery, and I do not say that the pleasures of hearing are not; but music has been taken to pieces by science, and we know what it is.

What music is

Music may be divided into three distinct elements—time, tone, and tune. *Time* comes first, for it is the one that is essential. There is no music without time, and time is always music. Time beaten with the fingers on the table is music. I remember, as a child, listening with delight to the regular sound made by a pair of horses trotting down the road. One took longer steps than the other, in the proportion, let us suppose, of 4 to 5. Taking four steps of one as a bar of common time, during which the other would take five steps, it is evident that the beats would fall at the following intervals:

Time

1 . . . . 2 . . . . 3 . . . . 4 1
1 . . . 2 . . . 3 . . . 4 . . . 5 . . . 1

and so on, with double emphasis on the first stroke of each bar, when the feet of both horses struck the ground at the same time. This was music to me, and if I had been insensible to it, it would have been music still. If the ratio between the steps of the two horses had been simpler, for instance 2 to 1, it would not have given me so much pleasure; but if if it had been less simple, 7 to 8 or 8 to 9, it might have been beyond me; that is to say, I should not have detected it, and could have perceived no music. But a man of more highly cultivated ear than mine would have preferred it. Our capacity for enjoyment in music, as in everything else, advances with the delicacy of our perceptions, and as soon as we are able to discern what is finer we lose taste for what is coarser, or more simple. Much of the music of Mendelssohn or Beethoven is 'caviarre to the general,' chiefly because the time is too subtle. A bar of common time is not divided into four equal notes, or eight half notes, or two whole and four half notes; but into seven, nine, or eleven notes of various lengths, among which an unpractised ear loses its way and cannot place the beats at all. And we may lay it down as an axiom that no succession of sounds, however sweet and harmonious, is music to a man who cannot beat time to it.

But a military band playing 'Rule Britannia,' or the 'Marseillaise,' with the big drum accentuating the beats, moves a whole regiment (including 'the general') as a strong wind moves a field of corn. No man who has any ear at all can help keeping step to the time of it. A more lively air, with well marked time, prompts to dancing. In this I think we may detect a rudimentary illustration of a profound and universal truth—namely, that every clear perception of law and order persuades us to action in harmony with it, and has its full fruition only in such action. Reader, track that truth and follow where it leads you.

The music of savages consists of little else than time, and among the natives of India, who are not savages, time is by far the most important element, for their melodies are simple and monotonous, and the tone of their instruments is generally harsh and unpleasing. But their time is very intricate, too difficult, in fact, for the average Englishman, who always speaks of native music with contempt and disgust.

The second element of music is *tone*, not indispensable, but very important. For though the rhythmic trotting of horses is music, it is not sweet music, because the rap of a horse's hoof on a hard road is not a sweet sound. Rhythmic sound gives double pleasure to the ear

Tone

when the sound itself is sweet. Wherein, then, consists the sweetness of a sound? To make this clear, we must draw a distinction between a *sound*, or tone, and a *noise*. In physical science a *sound* is the result of uniform, or regular, vibrations of the air. Crumpling up a letter in the hand, or overturning a cartload of gravel on the road, makes a *noise*, but striking a bell, or drawing a bow across a violin string, or blowing into a flute, produces a *sound*, because the bell, the string, and the column of air in the flute all vibrate uniformly according to a fixed law. We must next look at the three ways in which musical sounds may differ from each other. These are *loudness*, *pitch*, and *quality*.

Loudness may be dismissed in a few words. It depends upon the energy with which the sounding body vibrates, or, in scientific language, upon the amplitude of the vibrations. If a tuning-fork is struck gently it will sound softly, but if it is struck hard it will sound louder, because it will vibrate more violently, that is to say, it will pass through a greater space in its vibrations. A sound may also be made louder by multiplying it. Two tuning-forks will sound twice as loud as one (provided they sound the same note), and a tuning-fork rested on a table will give a very loud note, because it will set the whole table vibrating.

The second quality, *pitch*, has nothing to do

with the amplitude or energy of the vibrations that produce it. Whether you strike a tuning-fork hard or gently will make no difference in the pitch ; it will give its own note and no other. And you may produce a note of exactly the same pitch on a violin or flute, or any other instrument, and of any degree of loudness. By numberless experiments, which need not be described here, it has been shown that the pitch of a note, whatever instrument produces it, is decided simply by the rapidity of the vibrations, that is to say, by the number of vibrations per second. And this depends on certain properties of the vibrating body. Just as a pendulum of a certain length will swing backwards and forwards once in a second, and at no other rate,[1] so a tuning-fork of a certain size, weight, and shape will, under all circumstances, vibrate 435 times in a second, and send a succession of waves through all the surrounding air at that rate, which, striking on the ear, will produce the sensation that musicians have agreed to call 'a,' normal pitch. But stick a small piece of metal with sealing-wax on one of the limbs of that tuning-fork, and it will vibrate more slowly, and the ear will discover the difference by a lowering of the tone. But the question will at once suggest itself—if the pitch of

[1] This is absolutely true only when the arc of oscillation is small.

a sounding body depends simply on the number of vibrations per second that it imparts to the surrounding air, then all instruments sounding the same note ought to be exactly alike to the ear; why is it not so? As a matter of fact, we cannot only distinguish between a violin, piano, flute, harmonium and human voice—all sounding the same note—but we can distinguish between two instruments of the same kind. One, we say, has a sweeter, or purer, or richer, tone than another; and so great is this difference that, while a common violin may be had for ten shillings, musicians will give a thousand pounds for a Guarnerius or Stradivarius. In the human voice this difference is even more remarkable; no two voices are exactly alike.

This brings us to the third quality of musical sounds, that which musicians call *timbre*. This subject has been deeply investigated by Helmholtz and others, and illustrated by the most beautiful experiments; but if I were to attempt to give even an outline of the results of those investigations it would take up a volume to itself. All I can do here is to try to make plain to an ordinary reader, with no previous knowledge of the subject, what tone, or *timbre*, depends on. If the vibrations of sounding bodies were simple, that is to say, if the whole body just shook from side to side, as a

pendulum seems to swing, then they would indeed all have the same sound ; and a very poor, thin sound it would be. But no body vibrates in this simple way. Let us take a violin string for an example. When it is struck with the finger, the whole string starts into motion, and we can see something of the nature of the motion with the eye, though we cannot follow it. The middle of the string first swings to one side, forming a curve like a bow, because the ends are fixed, then recovers itself by its own elasticity and swings as far to the other side, and so backwards and forwards, with such rapidity that the outline of the string is blurred to our vision and we just see a quivering double bow. This is a simple vibration. But the string has other motions which are not so apparent. In the first place, it divides itself in the middle, and each half vibrates on its own account just twice as rapidly as the whole string, and this vibration must, of course, produce a sound. That subsidiary sound, or *harmonic*, is just one octave higher than the fundamental tone of the string. Again, the string divides into thirds, and each third vibrates three times as fast as the whole string, producing a note which is what in our scale is called the fifth of the octave, so it accords with both the fundamental tone and the octave. This harmonic, faint as it is, can be detected without

difficulty by a practised ear. But the string divides also into fourths, which give the second octave of the fundamental note, and into fifths, and so on; in fact, the whole string is quivering with a score of different motions at once, and its sound is really a harmony of many chords led by the fundamental tone. The same is true of the sounds produced by other instruments; in fact, of every musical sound; and the quality, or *timbre*, of each depends upon the blending of the harmonics and the preponderance of one or another. In strings of uniform quality and thickness there is little room for variation in this respect; but we must remember that the sound of a violin is not made by the string alone, which would scarcely be audible, but by those two wonderful sound-boards, the belly and back, which are started into responsive vibrations by every separate quiver of the string; but not equally—they will answer to some harmonics with more emphasis than to others, and their preferences will depend upon their own qualities, upon the wood that they are made of, its texture, the evenness of its grain, the very varnish with which it is coated; also upon every minute detail in the form of the boards themselves. These conditions are too subtle for science to trace. The violin in its present form is the result of gradual improvements suggested by practical experience,

during many generations, and perfected at last, after a lifetime of loving thought and labour, by the genius of Stradivarius. Here is a description of one of his violins by an enthusiast, the Rev. H. R. Haweis: 'The violins from 1700 to 1725 have all the grace and boldness of a Grecian frieze drawn by a master's hand. The curves are perfectly graceful; the arch of the belly, not too flat or too much raised, is the true natural curve of beauty. On each side the undulating lines, as from the bosom of a wave, flow down and seem to eddy up into the four corners, where they are caught and refined away into those little angles with that exquisite finish which rejoices the heart of a connoisseur. When the instrument is held sideways against the light, the curve of the back, without being exactly similar, is seen to form a sweep in delicious harmony with the upper arch. The Stradivarius is throughout a thing of beauty, and, it may be added, almost a joy for ever.' I have quoted this passage chiefly for the sake of these clauses, 'the curves are perfectly graceful,' 'is the true, natural curve of beauty,' and 'is seen to form a sweep in delicious harmony with the upper arch.' Is it not remarkable that the old violin-maker, studying with heart and soul how to delight the ear, was led into forms so charming to the eye? Remarkable, but not strange. For

it is just that perfect symmetry of form, so 'delicious' to the artist, that secures the perfect balance in the vibrations of every part to which we owe the full, clear, and mellow tones of those ancient violins. But this is a digression. The harmonics which give their various qualities to the tones of other instruments depend in the same way on differences in the substance and forms of the instruments, and those of the human voice upon the control which we are able to exercise over our vocal organs. So much for tone.

Tune

The third element of music is *tune*, which consists in the relation of the successive sounds to one another with respect to their *pitch*. A tune is a succession of musical sounds in regular rhythmic time. But, in practice, it is found that sounds, however sweet in themselves, cannot be combined promiscuously. Whether sounded simultaneously or in succession, they are not only not pleasant, but are positively disagreeable, unless there is a certain relation between them with respect to their pitch. This limits very much the number of sounds available for musical purposes, and the first step in musical composition is the selection of a scale, or scheme of notes, which will be endurable in combination. We may start with any sound, for it is not absolute, but relative, pitch that concerns us ; but having chosen a start-

ing note, we are restricted afterwards to those above and below which the ear will allow with it. The most obvious one is the octave of the starting note, which is so perfectly consonant with it that the two, when sounded together, strike the ear as a single note. They are, indeed, practically the same note; when a child learns a tune from a man he sings it an octave higher without knowing the difference. Between the starting note and its octave there are a number of others which are approximately consonant with both and with each other. Of these modern European musicians have accepted six, and so formed a scale of eight notes. Let us now look at the relation of these to one another, as science has revealed it. We will take a violin string again as our illustrator, and call its tone C. Divide it in the middle, and the half string will sound the octave, C^1. But we have already seen that the half string vibrates just twice as rapidly as the whole; so it appears that in the note C^1 there are two pulsations of the air for one in the note C, and the reason why they are so perfectly consonant is plain, for the two together are just $C,^1$ with every second beat doubled in loudness. Next divide the string at one-third of its length. It will vibrate at three times the rate of the whole string, and the resulting note will be what is called in music the fifth above

The musical scale

the octave, that is, the octave of the fifth note in our scale. Our fifth note, G, then, is just this note lowered one octave, and its vibrations must be three to two of C, and three to four of C^1. Similarly, it is found that our third, E, has exactly five vibrations to four of C. These four notes, then, vibrate at rates which stand to one another as 4, 5, 6, 8. Get four persons to tap on the table in exact time at these rates per second, and you will see without further argument why the four notes, C, E, G, C^1, when sounded together, produce such a pleasant combination of sounds that they are called the 'perfect major chord.' In the remaining notes of our major scale the ratio is less simple, and they are not so perfectly consonant either with C or with one another. In D the vibrations stand to those of C as 9 to 8; in F, as 4 to 3; and in B, as 15 to 8. So, if we call C = 1, the vibration rates of all the notes of the scale may be expressed thus:

C,	D,	E;	F,	G;	A;	B,	C^1.
1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{3}$	$1\frac{1}{2}$	$1\frac{2}{3}$	$1\frac{7}{8}$	2

or, getting rid of fractions, thus:

24 27 30 32 36 40 45 48.

The Greek scale, which was long used in Europe, was much less simple in its ratios; but the

Greeks made no use of harmony. Notes will follow each other pleasantly enough in a melody which would grate on any sensitive ear when combined in chords. Accordingly, the wonderful development of harmony, which began about four hundred years ago, necessitated a more consonant scale, and our major and minor scales were gradually evolved. The minor scale differs slightly from the major; but we cannot spend more time on that subject here. Even in what I have said of the major scale I have only touched the surface of the subject. The value of each note in the scale does not depend solely on the number of its own vibrations, but on the *resultant* or *difference* notes, which rise whenever two notes are sounded together, and on their relation to the other notes of the scheme; and there are many other matters, each of which would require a long digression to make it intelligible, which must be passed over without notice at all, because I am not writing a treatise on music, but simply trying to bring out one fact. That fact will only be re-affirmed by every further step that the reader may take on his own account in the subject. It is this, that the third element of music, namely *tune*, whether melody or harmony, proves, when investigated by science, to consist of nothing else than such an arrangement of musical sounds that the vibrations of the air

which come together or follow one another shall have a simple arithmetical relation. Two notes in a chord are essentially the same thing as two horses trotting down the road together, each stepping in perfect time, but at rates which stand to each other in some simple ratio, such as 3 to 4 or 4 to 5. And we have already seen that the sweetness of a musical tone is just the same thing in another phase.

Summary

It appears, then, that music consists in orderly motions arithmetically related to each other. They may be very simple, or infinitely complex; in either case, the pleasure that they give depends upon their obedience to simple laws governing their mutual relationship. In an orchestra there are several hundred instruments simultaneously sounding a number of different notes, which, though ranging over several octaves, bear simple ratios to one another in their rates of vibration; again, each note is a compound sound, consisting of a fundamental tone and a number of harmonics, whose rates of vibration are all multiples, or sub-multiples, of each other; again, the succession of tones which make up the melody is governed by the same rule, the rate of vibration of each being simply related to that of the one which precedes it; and, lastly, the march of the whole is governed by the measured rise and

fall of the conductor's wand. Thus the whole air of the concert hall is kept quivering with an inconceivable complexity of motions following one another as fast as fingers nimble with years of practice can move ; but if an unskilful player, or an ill-tuned string, introduces one wave of motion which is even a very little out of its right relation to the rest, it mars the whole and gives pain instead of pleasure to a sensitive ear.

This is not strictly true, however ; in fact, it is literally untrue. Discords are extensively used in music. It would be very insipid without them—too monotonously sweet. The sense of touch has already taught us that the keenest pleasure is found on the borders of pain, and this has been corroborated by taste and smell. Musicians have found that the fact must be recognised in dealing with the ear, and that the 'concord of sweet sounds' must be spiced with discord in order that it may afford the highest degree of delight. Is this not just another phase of 'the mystery of pain'? But it does not shake the truth that music is concord, not discord. Out of every discord concord must be evolved, and every piece of music must end with a perfect chord. Thus does music mirror for us 'the creature made subject to vanity by reason of Him who hath subjected the same in hope.'

But we must not speak of the pleasure that we derive from music as if that were the whole, or even the chief part, of its significance. It has been well described as the most powerful medium we have for the expression of the emotions, and it does more than express them—it excites and controls them, not only in man, but, as we have seen, in beasts and reptiles, and 'creeping things' like scorpions. From what has gone before we may get an inkling of the manner in which this influence operates. We have seen how the simplest element of music namely, rhythmic time, constrains the motions of our bodies and limbs into harmony with itself, so that we march to martial music and dance to lighter measures. Is it not possible that those ordered movements, which science has discovered to be the substance of every pure tone and true concord, have a like power over the motions of the brain which are the 'physical basis' of every thought and emotion? It is more than possible: it is extremely probable, I should say almost certain. If this is so, then the influence which music exercises over the feelings will be accordant to the character of its own movements. This is a perilous subject; but let us venture a few steps further into it, taking for our clue some of the terms which we employ by common consent

Music and the emotions

when we speak of musical matters. Dryden says that

> The trumpet's loud clangour
> Excites us to arms
> With its shrill notes of anger;

but

> The soft complaining flute
> In dying notes discovers
> The woes of hopeless lovers.

What is the difference between *shrill* and *soft*? From a small, but excellent, manual on 'Sound in its Relation to Music,' by Professor Pietro Blaserna, I take the following sentence: 'When the fundamental note is accompanied by the lower harmonics 2, 3, &c., it acquires a broad, open, *soft* character. If, on the other hand, it is the higher harmonics that prevail, the sound acquires a *shrill*, or clanging, character, as, for example, in the trumpet.' Now let us suppose, for the sake of simplicity, that in the flute there is only one influential harmonic, the second, and in the trumpet also only one, the fifth. Then, if we sound C natural, in the middle of the stave, on either instrument, we shall have a tone of 264 vibrations per second, supported and modified by a low accompaniment of one harmonic note. But in the flute this note will be the octave of C, with a rate of vibration of 528 per second, while in the trumpet it will be the second octave above E, whose rate is 1320. So, while the main

pulse of the tone will be the same in both cases, it will be accompanied with a by-play of air ripples stirring the brain at the rate of 528 per second in the one case, but 1320 in the other. We need not go further, surely, for an explanation of the contrast between the musical influences of the flute and the trumpet.

Of course there is exactly the same difference between the effects of a low and a high pitch, and even of slow and quick time.

Again, we are accustomed to talk of the minor scale as being suited to plaintive music; sad songs are, as a rule, set to tunes on a minor key, but martial and cheerful songs to tunes on a major key. What does this mean? The difference between the two scales seems very slight. In practice it amounts to little more than this, that the semitones do not occur in the same places. In the minor chord the intervals are exactly the same as in the major chord, only differently arranged. This scarcely accounts for the felt difference in the character of the two chords, and of all music based on them. No; the cause of that lies deeper, in the *resultant* notes. These, to which I have already alluded, are feeble tones which rise, like harmonics, whenever two notes are sounded together. In every chord a great deal depends upon these resultant notes, and on the manner in which they harmonise

with the other notes of the chord. Now, in the major chord the resultant notes are, first, the second octave below C; second, the first octave below C; third, the octave below G; and, fourth, C itself. So they all reinforce the notes of the chord and simply add strength to it. But, in the minor chord, two of the resultant notes are at discord with one of the notes of the chord, and, though they are too feeble to make the chord actually dissonant, they distinctly disturb its harmony and introduce an element of uncertainty and pain into the sensations which it conveys to the ear. The minor chord, therefore, and all music based on it, though it may be sweetly harmonious in the main, and not exciting, but soothing (if the pitch is low), is always mingled with an imperceptible something which crosses the pleasing effect and dashes it with a sense of pain. And if, as Shelley says,

> All our sweetest songs are those that tell of saddest thought,

then it is the right music for such songs, for the sensations which it excites in the brain are in close accord with the feelings which they express.

We might pursue this investigation further by taking up a few of the masterpieces of music, and analysing them and comparing the very complex, but definite and ascertainable, motions of the air in which they consist, with the effects which they

are universally felt to have upon our emotions when we hear them. Turn, for a striking example to the Dead March in 'Saul,' and note how every element combines to give an overpowering emphasis to the successive steps of a few slow, measured and repeated movements; then see how the whole current of thought, imagination and feeling is, by that heavy march of sound, brought under restraint, and compelled to a great, united, sorrowful progress, such as pervades the whole man and expresses itself outwardly in the downcast eyes, silent lips, and slow, solemn tread. In the simple, but strongly impressive, tune of 'Scots wha hae wi' Wallace bled,' the movement at first is of a very similar character, but the pitch rises, step by step, and the excitement of the emotions rises with it, till the climax is reached in the last line but one, 'See approach proud Edward's power,' after which the tune sinks again to the note on which it began, dwelling on that through a whole bar, and the feelings are sobered down to the restrained, deliberate, determined passion of a strong man. Songs often fail through the tune, which expresses one verse perfectly, being unsuited to another; but here the genius of the poet has helped the composer by leading the march of emotion round almost exactly the same course in the three verses. For a contrast to 'Scots wha hae,' look at 'Auld

Robin Gray.' It also begins low, very low, and rises to a scream in the last line of each stanza; but not by measured steps. It goes up and down, up and down, with every turn of sentiment in the words, unsettles the orderly intervals of the scale by accidental flats or sharps, and completes the effect by making any steadfast impression impossible with its distracted and vacillating time.

But I have said enough. If music influences the feelings by swaying the motions of the brain into sympathy with its own harmonious vibrations, as I am persuaded it does, then these examples are enough to show how the musician, by directing the varied tremors of the air according to his will, may stir the passions to a state of feverish excitement, or marshal them to a strong, steadfast and resolute march, or subdue them to a gentle, calm and even flow. So when David, with his serene and exultant faith in a mercy which is in the heavens, and a faithfulness which reacheth unto the clouds, and a lovingkindness which is better than life, poured out his melodious soul in songs without words upon his harp, the storm of devilish passions that seethed in the turbid mind of King Saul was calmed, and the currents of sweet reason and right feeling flowed again as

they were wont to do when he was a humble and blameless man.

Some strange, and, I think, not unfruitful, thoughts have risen in my mind as I have pondered on this subject.

1. First, it is to be noted that those motions in which we find music are the working of universal and eternal laws. The discovery of the laws of motion by waves in elastic fluids, and of vibration in a string, or a bell, or a column of air in an organ pipe, is a very recent triumph of science; but, once having discovered them, we feel assured, in fact we *know*, that they must prevail wherever there is solid matter to vibrate, or a gas to move. In Sirius, or the pole star, there can be no other law. And the mutual relations of numbers which govern pleasing combinations of musical sounds rest on the axioms of arithmetical science, which we cannot conceive to be different in any possible universe. But other motions than those with which we are concerned just now are also under unchangeable laws. Light cannot flash, nor a wind blow in the sky, nor a wave roll on the ocean, nor a comet travel through space, without working out some problem of arithmetic and mathematics. So there is more than poetic fancy in the thought suggested to Lorenzo

Deductions and reflections

by hearing the 'touches of sweet harmony' on a beautiful night:

> There's not the smallest orb which thou behold'st,
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubims:
> Such harmony is in immortal souls;
> But while this muddy vesture of decay
> Doth grossly close it in, we cannot hear it.

2. Secondly, it is almost a startling thought that, though knowledge *about* these things comes by science, the apprehension and enjoyment of the things themselves comes only by a direct perception of the sense of hearing, which was before knowledge, and is to the last independent of it. A man may master all that is to be known about the laws of sound, but if he is devoid of that mysterious faculty, an ear for music, he will never know what music is. If he should sneer at the man who dances to 'all measures of delightful sound,' and prove to him that his transports are unreasonable and childish, what shall the latter say?

3. It is well worth noting in this connection that, while the faculty in question is innate in all men, except a very few who are born defective, the right use of it comes by culture. We have already seen that an infant has to learn how to use its ears from the very beginning, and that it only acquires

by slow degrees the skill to interpret common sounds and fix their direction and distance; and everyone who has had to teach music knows how much the musical ear is improved by training, even in those who are most richly endowed with it. At first its perceptions are slow, and its decisions uncertain, but by exercise it becomes both quick and sure in approving what is right and detecting what is wrong. And as it may be improved, so it may also be deteriorated. Familiarity with what is false and bad will debase the finest ear, and create in it a vicious taste. This is an allegory, and the moral of it is, 'Take heed, therefore, how ye hear; whosoever hath, to him shall be given.'

4. Another remarkable thing is that, though the laws which govern music are in force everywhere, there is scarcely any music in nature. The howling of the wind is a musical tone, no doubt; but it slides up and down without definite intervals, and its course is subject to no discernible measures of time. In the murmur of the sea there may be harmonies—I am inclined to think there must be—but they are so promiscuously mixed up that we cannot unravel them, or else they are beyond the range of our sense. We are accustomed to speak of the music of birds, but it is only a conventional misuse of the word. There is an attempt at

regular time in the songs of most birds, and the tones of some are pure and very sweet; but the intervals are not musical, and so there is no melody in the song. The pleasure which they give us is due chiefly to their infectious gladness, which, like the laughter of children, makes us glad. Every poet who has written an ode to any kind of song-bird bears unintended testimony to this. Hear Shelley on the skylark:

> Thou art unseen, but yet I hear thy shrill delight,
> Sound of vernal showers
> On the twinkling grass,
> Rain-awakened flowers,
> All that ever was
> Joyous, and clear, and fresh, thy music doth surpass.

Or Wordsworth, on the green linnet:

> A life, a presence in the air,
> Scattering thy gladness without care,
> Too blest with anyone to pair,
> Thyself thy own enjoyment.

Or Keats, on the nightingale:

> 'Tis not through envy of thy happy lot,
> But being too happy in thy happiness,—
> That thou, light-winged Dryad of the trees,
> In some melodious plot
> Of beechen green and shadows numberless,
> Singest of summer in full-throated ease.

And I do not know where else in the world we shall find anything that can properly be called

music. And the reason is plain. The laws of harmony are in force, but the instruments which should obey them are wanting. Nature does not produce perfect tubes and symmetrical sounding boards. Everywhere there is some unsymmetry and imperfection, and therefore true harmony is nowhere. From this it appears that, in the 'ear for music,' man has an endowment reaching beyond the conditions of his present state, a faculty fitted for the perception of something which is only an ideal, with no corresponding reality anywhere to be found until he realises it for himself, or—shall we not rather say?—until it is realised for him by some divinely gifted one, some prophet in that kind. Then, when the prophet has revealed it, all men recognise it and feel the power of it. Is not this also an allegory?

CHAPTER VII

LIGHT

WORKING from below upwards, as we are doing, the sense of sight comes naturally last, because it is the highest and most perfect of all, the one that supersedes every other whenever they come into competition. It is at once the most rapid, exact and certain in its perceptions, and beyond all comparison the most far-reaching in its range. By the sense of touch we know only of such objects as our limbs can reach, and taste can deal with nothing until it enters the mouth, or, at least, comes in contact with the tongue. The nose, indeed, gives intimation of things which may be a mile away or more; and the ear will bring us news of great events, a volcanic eruption for instance, from a distance of several hundred miles. But the eye ranges away beyond the limits of our world, and, piercing the depths of space, finds other worlds and suns beyond suns at distances which, if we could state them in miles, no mind could take in. Again, we

The highest of the senses works by light

are more or less dependent on accident for opportunity to use the other senses. A thing must be giving off an odour and the wind must be helping, or at least not hindering, if the nose is to know of it; while the ear cannot become aware of the existence of anything at all unless it moves and stirs the air. But the light with which the eye works is everywhere—even in the darkest night there is some light—and whatsoever it falls on, be that thing at rest or in motion, willing or unwilling, the light will strike it, and, glancing off, carry its tale to the open eye. Lastly, light moves in straight lines—it can move in no other—hence every ray that falls on the eye brings with it the story of whence it comes. We can only guess at the direction from which a smell or a sound has come to us, but there is no uncertainty about the situation of anything that the eye can see. There is an exception to this. When light passes from one medium into another, from water into air or from air into water, it is 'refracted,' or turned aside from its original course. This misleads us, so that a thing seen at the bottom of a clear pond is never just where we see it to be, and an oar dipped in the water appears crooked. But this is of very little practical consequence, except to kingfishers. Our eyes are intended for seeing in air, and in air the course of light is straight as truth

itself. This very property of light, however, is the cause of the most important limitation of the power of sight. It is just because light travels always and only in straight lines, and can by no means get round a corner, that a sheet of paper coming between the eye and any object is enough to cut off all knowledge of that object.

What is this light which serves us so wondrously? That is not an easy question to answer. In fact, it would not be far from the truth to say that, in our present state of knowledge, there is no answer to it. We cannot say that light is a *thing* at all. It is like an adjective without a noun, a verb without a nominative. It is and it acts, but we can find no *It*. Let us say it is a *state*, and look first at those characteristics of it which are obvious, or can easily be made obvious to anyone. Afterwards we may have to go a little deeper and take some things on trust.

What is light?

When a gunboat turns its searchlight on a distant shore there is an instantaneous change in the condition of things on that shore. Instead of darkness there is light, which to us means that instead of invisibility there is visibility. This condition is clearly produced by something that emanated from the ship. Open a window in a dark room on a bright, sunny day, and the same change takes place in

Something that illuminates

the room. In this case the influence, or whatever you will, which has brought about the change has emanated from the sun. We think we can plainly see it in the form of a broad stream, of what we call sunshine, extending from the open window of the room to the opposite wall. We do not need scientific proof that this comes from the sun. The common experience of humanity has settled that long since. The sun is the great searchlight which transforms everything on this earth from a state of darkness to a state of light. Its effulgence was outside, beating, as we say, on the wall of the house, and when we opened the window it came in. But we cannot by shutting the window keep it in. Try that, and in an instant it is gone ; not a vestige of it remains. If it were a substance, then so much of it as was inside the room when we shut the window would remain inside ; and if it was a condition, or an effect, produced in the walls or air of the room, like other conditions of which we have experience, such as heat, cold, or dampness, then that effect would surely take some appreciable time to pass away. But it is not so. This effect ceases the very moment we break connection with its cause. It seems to come instantaneously, or, rather, not to come at all, but just to be, or cease to be, as things do when a conjurer says, 'Presto!' But this is a mistake, which was

first found out in a curious way. In the year 1676 an astronomer, named Röemer, noticed that the moons of the planet Jupiter were not quite punctual in performing their eclipses, and that there was a certain method in their unpunctuality. When the earth was at that point of its course which was nearer to Jupiter, the eclipse would occur about eight minutes too soon; but when the earth was on the opposite side, it occurred eight minutes too late. If the earth was at either of the intermediate points, the eclipse occurred just at the time fixed for it by astronomers. The thought came to him that perhaps light might require sixteen minutes to traverse such a great distance as the diameter of the earth's orbit, which is about 196 millions of miles. Other observations confirmed this, and afterwards, by most ingenious experiments, which it is impossible to attempt to describe here, the velocity of light was exactly ascertained even at short distances on the surface of the earth. It is 183,200 miles per second. So it appears that the light which brightens the earth at any particular moment left the sun seven or eight minutes before. The last news we have of the sun is always seven or eight minutes old. It may have gone black, or red, or gone out altogether, since that time; but we shall know in a few minutes.

And travels

Its rate of motion

Now, if this light, which has just arrived at our earth after a journey of more than ninety millions of miles, were not stopped by the earth, it would of course go on at the same speed through space for a time to which we can put no limits. And, of course, the greater part of the light that issues from the sun does go on. The earth, like an umbrella in a shower of rain, receives on its surface an infinitesimal fraction, and interrupts its course. What does it do with it?

Let us return to the dark room, and, opening the window again, see what else we can discover.

Reflection

If a mirror is placed in the path of the sunlight from the window, it is thrown back strongly on the wall, or the roof. A plate of bright metal has the same effect, and a sheet of white paper has it in a more diffused and indistinct way. Paper which is not quite white has it in a less degree, and it diminishes with every deepening of the shade until we come to black, when it almost ceases altogether. And now we see how it is that letting in a beam of sunlight through the window illuminates the whole room, and not only that part of the opposite wall on which it falls. For the wall throws it back upon the opposite wall, which again throws it back, and so on until the whole apartment is filled with beams of light, crossing and recrossing in every

direction, and producing a general state of illumination, which makes everything visible to our eyes. But here we must note one important thing. If the mirror is held in such a position that the sunlight from the window will fall upon its surface perpendicularly, then it will be thrown back in the same direction from which it came, and will go out at the window again, leaving the room almost as dark as it was before the window was opened. But when the mirror is held at a slope to the light, then the light glances off it at a like slope in the contrary direction. Experiment will prove that there is no uncertainty about this: at whatever angle light falls on any perfectly smooth reflecting surface, it will go off in the opposite direction at exactly that angle and no other. In this it behaves just like a tennis or racquet ball, for both are under the same law. No game with elastic balls would be possible if we could not depend on this law with absolute confidence.

So much for 'reflection,' as it is called in optical science. But we have seen that, whereas a mirror reflects nearly the whole of the light which falls upon it, a black substance reflects very little, if any; and other substances seem to reflect more or less according to their shade. What is not reflected is absorbed in some way, lost in the substance on which it fell.

Absorption

Lost is a bad word, for nothing is ever really lost in this universe (except misspent time); but the word will serve us here, for when light is not reflected it is lost to us as light. There are some substances, however, which do not seem either to reflect or absorb the light which falls on them, but to let it pass right through them and come out on the other side. We call them 'transparent' substances. In all these respects the light of a candle behaves in exactly the same way as sunlight.

Transmission

To sum up, then, we find that light, whatever it be, proceeds from luminous objects, moves in straight lines at the rate of 183,200 miles per second, till it meets with some material substance, when it either passes through it, is stopped and absorbed by it, or rebounds from it as an elastic ball would do. As a matter of fact, it does a little of all three. Gold can be beaten so thin that a little light will pass through it; the clearest glass reflects some, else we could not see it at all; and the brightest and whitest substance absorbs some. Which of these three things will happen to the greater part of the light depends partly on the substance and partly on the angle at which the rays of light take it. White and light tints, as we have seen, reflect, while dark tints absorb, and colourlessness is transparent. The angle at which

the light falls affects the result in this way, that, if it falls perpendicularly, more of the light is absorbed, and if it falls obliquely, more is reflected. When the sun is rising there is a blinding glare from the sea, for the light, striking the surface of the water at a low angle, just skims it and goes off again, like a flat stone skilfully thrown ; and the scientific way of stating this is to say that almost the whole of the light is reflected. But at noon you may look over the side of a ship into the blue depths below, and your eyes will feel no distress.

Now, how does light behave when it is not reflected, nor absorbed, but passes through a substance ? I have already referred to the familiar fact that an oar partly dipped in water looks crooked. A very simple experiment helps to make the cause of this plainer. Put a coin into an empty basin and look into the basin from the side, so as just not to see the coin ; then let somebody fill the basin with water and the coin will come into sight. In this experiment the coin is at first invisible because the side of the basin intercepts a straight line from it to the eye, and light will travel in straight lines. But when light passes from water into air, or *vice versâ*, it changes its course ; and so, when water is put into the basin, the rays which start from the coin in a direction

Refraction

which should take them over our heads actually find their way to our eye, and we see 'round the corner.' This 'refraction' of light takes place whenever it passes into or out of water, or glass, or any other transparent substance, unless it strikes it perpendicularly; in that case it goes straight through. When we look through a pane of window-glass we do not notice the effect, simply because, though the light does turn aside a little when it passes into the glass, it turns again in the opposite direction when it passes out, so that it goes on in the same course as before. But if the two surfaces of the glass are not parallel, the course of the light will be permanently turned aside. Take a piece of glass, the surface of which is straight on the one side but curved on the other, and let the rays of the sun fall perpendicularly on the flat surface. They will go straight through the glass till they reach the curved surface, when they will turn aside. And the degree to which they will turn aside, or be 'refracted,' will depend upon the angle at which they strike the curved surface. The ray which passes through the centre of the glass will go straight on; those near it, on either side, will be slightly refracted; those further off more so, and so on. And so strictly is this refraction controlled by mathematical laws that, if the curve is a true

A lens

segment of a circle, then all the rays will come together at one point on the line of the ray which has passed through the middle of the glass. Such a glass is a 'lens,' or 'burning-glass,' and the point where the rays meet is called the 'focus' of it. The distance of the focus depends upon the sharpness of the curve, a fact which we must bear in mind as we go along. If such a glass is held in the rays of the sun and a sheet of paper placed at the right distance behind it, the focus will appear as a point of dazzling light, and the paper will be set on fire, which shows that the heat of the sun's rays is refracted along with the light. Heat and light are, in fact, degrees of the same thing; but that is a little outside of our subject just now. Instead of having one surface curved and one plane, a lens may have both curved, in which case the rays of light will be refracted both when they enter the glass and when they leave it, and the effect will be increased.

If, instead of holding the lens to the sun, you hold it opposite to an open window, and hold your paper in the focus, then you will not have a point of dazzling light, but a miniature sketch of the view which is visible from the window. The explanation is very simple. Suppose that in front of the window there stands a tree in the full sunlight. Each leaf of that tree is reflecting sunlight

to your lens, which, after passing through it, is gathered together on the other side at a point corresponding exactly to the direction from which it came. If the leaf is in the full sunshine, it reflects much light; but if it is in the shade, it reflects little, and so the lights and shades of the tree are faithfully reproduced on the paper. But since the light from the top of the tree will pass downwards through your lens to a point below it, while the rays from the foot of the tree will pass upwards, it follows that your image will be inverted; the tree will stand on its head, and right will be left and left right. A common eyeglass, or pair of spectacles, will illustrate this; but to get a clear image it is necessary that there should be no cross lights. Therefore, shut every window but one. The experiment is worth making, for it helps one very much to understand the working of the eye. There is no eye in the world without a lens.

Here I must stop to look at one of those deep things, those subtilties, which meet us at every turn as we follow this subject, and confound us with wonder. I generally pass them by, fearing to cumber the subject, and content myself with stating what is true enough for the purpose in hand, though not strictly correct; but I cannot pass this by. I have spoken of a lens as a glass with a curved

surface, the curve being a true arc of a circle, and, as a matter of fact, all the lenses we use are made so, and they serve their purpose. But such a lens cannot form a perfect image. If we wish for perfection we must make a lens of which the curve is a parabola. And what is a parabola? It is a figure that you get by cutting a cone in a direction parallel to one of its sides. A true cone is not a figure which you often meet with in nature, but it is used in art. Loaf sugar is generally made in cones, and a candle extinguisher sometimes has that form. Take a sugar loaf then, and divide it into two by a straight cut parallel to one of its sides, and the cut surface will be bounded by a curve, which is a parabola. This curve will evidently differ a good deal, according as the cone is high and narrow, or broad and flat; but it follows a fixed law and admits of mathematical definition. The definition is this:—'A parabola is a curve of which any point is equally distant from a fixed point, called the focus, and a fixed line, called the directrix.' This looks like a mathematical curiosity invented to amuse and exercise the minds of students; but it is not that—it is one of the foundation stones on which this universe is built. Whenever an arrow is shot into the air and falls to the ground again, it traces a parabola in its flight. The same curve is the appointed path of

some of those comets which come out of infinite space to visit our sun and depart into infinite space again. Ponder the fact that this particular kind of curve, and no other, is empowered so to redirect all rays of light from all quarters that they shall be gathered together and marshalled in exactly the same order in which they stood at their starting point.

The spectrum

One experiment more with a bit of glass—a very familiar one this time—which has delighted us all in our childhood and often since, and may do so again ; for, as old Wordsworth says :

> My heart leaps up when I behold
> A rainbow in the sky :
> So was it when my life began,
> So is it now I am a man,
> So be it when I shall grow old,
> Or let me die !

And I am free to confess that not only a rainbow in the sky, but a little one dancing on the wall as I turn a prism in a sunbeam, delights me still almost as much as my children. It is something so radiant, so pure, so perfect in its loveliness, that it scarcely seems to belong to this earth. It is like a visitor from some celestial region, clothed with the glory of its native place. And so it is indeed, a veritable angel sent from heaven to make us glad,

not only now, in this apparition, but everywhere and all the day.

> . . . Earth's crammed with heaven,
> And every common bush afire with God ;
> But only they who see take off their shoes.

For this miniature rainbow, scientifically called a 'spectrum,' is only a ray of common light, unravelled for us by the prism, as you can untwist a sevenfold cord into its variously coloured strands. By several ingenious experiments it has been shown that if we merge those seven colours into one again we get a ray of white light. And all the light that shines upon hill and plain is made up of glory such as this! This little three-cornered bit of glass has let us into the mystery of all the beauties of the earth and sky. For that which it has flashed upon us in one luminous revelation is even that which is being shown to us all the day by blue hills and green fields and yellow corn and purple heather. Let us see how. The prism, with its widely divergent surfaces, must of course refract the light that passes through it far more sharply than a common lens. Now, the ingredients, if I may use such a domestic word, of a ray of light are not equally subject to refraction. Some are turned out of their straight course to a greater degree than others. So, when the whole ray is twisted so

severely as a prism twists it, the different elements get quite separated from each other and thrown upon the wall in a certain fixed order; first the red, which is refracted least, then the orange, and so on to the violet, which is refracted most. But everything on which light falls is separating its elements in some degree, by reflection and absorption, concealing one that it may reveal another. Hold a pane of red glass in the way of the light from the prism, and the spectrum is no longer on the wall. The red of it is there, but the other colours are gone. They are not changed, but absent; the glass has barred their way. But it has given free passage to the red. And now we see why the glass is red. We thought that redness was some quality of the glass. No such thing. The red glass is red simply because it allows no light but red light to pass to our eyes. And so with everything else. Seven-hued light falls upon the fields, and the grass absorbs all its colours except the green; but the poppies keep the green and yellow, and send off the red alone to tell the bees that they are in bloom, while the buttercups let the yellow rays glance off their petals, but swallow up all the rest. The beams that shoot from the rising sun are the same as those that fall upon us at noon; but, coming through hundreds of miles of atmosphere, they have to pay tribute of their substance to mists and watery vapours, and to

every mote that floats in the lower air. So they reach the fleecy clouds faint and pale, but radiant still with a rosy and golden glory. The clouds send them down to the sea, which meets them with an ever-changing face, and, catching them at all angles, throws them off in undefinable tints of grey, or green, or blue. But the same rays, striking the atmosphere at a higher level, are shorn by its fine floating dust and motes of every hue except that pure blue which they pour down upon us through the rifts in the fleecy clouds; and this also, falling on the face of the sea, plays bo-peep among the waves with the light from the clouds. But when the sun is overhead, then his light comes down upon all things alike in its full strength and whiteness, upon water in all forms—as cloud, wave, snow, or deep and silent pool; upon barren rock also, and verdant field and flowery meadow, and upon many-plumaged birds and butterflies and bees. And all things are unceasingly at play with it, throwing it back at the sky, tossing it to and fro among themselves, catching it from one another, keeping part and flinging part away, dividing, combining and blending. The mind is stupefied with the contemplation of the game which has gone on without a break since first the fiat went forth: 'Let there be light.' And now, in the end of the world (for, relatively to the ages that have passed, it is surely

the end of the world) there has come into the midst of it all the perceiving eye.

Once again let us ask, What is this light? As the mind will not rest without an answer, men of science have invented one, to hold the place for the truth till it shall come. They have supposed the existence of an ether, something without weight or resistance, filling all space and penetrating all matter, the motions of which are light and heat, for these two appear to be only different degrees of the same thing. Of this 'half-discovered entity' Lord Salisbury said, rather neatly, in his famous address before the British Association, that 'for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb "to undulate."' For though we know little else, we know this, that the motion which we call light must be an undulation, or wave-motion, like those motions of the air which we call sound. How we know this I will not attempt to explain, because, to those who know nothing of the subject, it cannot be explained without explaining a hundred other things first, which would mean writing a treatise on Physics. In matters of this kind men of science are the Church, and common people must accept her teaching in faith. The question of infallibility

Again, What is light? The ether and its motion

is a burning question in both spheres, but we need not set it on fire in these pages. Suffice it to say that a heretic who, in the present day, disputed the fact that the motion of light is a wave-motion, would not be worth burning. But we must consent to even a greater strain on our faith. We must believe that the waves of light have actually been measured. The way in which this has been done is very ingenious and beautiful; but again I must refrain from making any attempt to explain. Those who do not know anything of the subject, and would like to have some understanding of these mysteries, cannot do better than get and study a little treatise by Professor Tyndall, called 'Notes on Light,' which, for perspicuous brevity, beats almost anything I have seen. In measuring the waves of light it has been found that the different colours have different wave-lengths. In red light there are about 39,000 waves to the inch, but in violet twice that number. So it appears that colour in light is just the same thing as pitch in sound, and the spectrum is an octave. All about us the air is vibrating, set in motion by everything that moves; and the ether is vibrating, set in motion by everything that shines. The ear thrills to the one, and the eye to the other. If the vibration is rapid and short, like the ripple with which a breeze crisps the surface of a pond, then

the ear calls it a shrill tone, but the eye calls it violet or blue. When the vibration is long and slow, like a swell on the ocean, the ear calls it a deep tone, and the eye calls it red. We have already considered the wonderful structure through which the motions of the air are registered in the brain and become sounds to the mind: let us now try to understand, as far as we can, what it is that happens within us when we see.

CHAPTER VIII

SIGHT

BEFORE Life had a window to open to Light, Light was long knocking for entrance into Life. This deserves to be thought on. We are accustomed to speak of light as having been made for the eye; but, if we look at the sequence of things, it will appear that the eye was made for light. Before there was ever an eye in this universe light was there, and it was not, like the gods of the Epicurean, a thing apart, existing in itself and for itself, but a beneficent presence, everywhere working for life, and drawing life, by some strange influence, undisclosed but universally felt, towards itself, upward. Without light there is no life; darkness is death. Life from its first beginnings yearns for light and gropes for it and struggles towards it. When a seed germinates in the ground, it sends a slender root down into the moist earth for food, but itself pushes upwards and spreads its two leaves, like infant hands, to the light; and thenceforth all its

Light knocking at the door of life

growth is towards that quarter from which the light comes to it. Plants in a room grow lop-sidedly towards the window; the long, supple arms put forth by creepers actually follow the sun in his daily course; and flowers turn this way or that to face him. Many plants fold their leaves and close their flowers as soon as the darkness falls upon them. To the contemplative botanist a tropical forest presents the scene of a vast, unintermitted scramble for light; tree racing with tree to overtop its neighbours; vine and climber laying hold on anything that will help them upward; orchid and mistletoe playing the part of the wren in the fable, which boasted that it could fly higher than the eagle. And animals, no less than plants, need the light. Even man grows wan and lifeless in the dark dungeon or the student's chamber.

The birth of the eye

There can be no doubt that many animals in the lowest walks of life, though they have no eyes, are more sensitive to this influence than we are. Oysters close their shells instantly if a bright light is thrown upon them, while other shell-fish shut up when a shadow passes over them. We must suppose that the whole skin in these creatures feels the touch of light. And if so, some parts must feel it more than others. In India a man sitting in the sun feels the heat painfully in his feet if his boots are black; so the

darker parts of any animal, absorbing more light than other parts, will feel it most distinctly. Then, again, some parts may be more sensitive than others, as our finger-tips are more sensitive than the backs of our hands. Now, many animals, jelly-fishes for example, have dark spots, formed by minute drops of some dark pigment, in their otherwise colourless substance. Light passes through a jelly-fish almost as completely as it does through a pane of glass; but these pigment-spots must arrest it, and when dissection shows a fine nerve running to each pigment-spot, we are justified in guessing that here is the rudiment of an eye; that, in fact, this pigment is there for no other purpose but to catch the light and stop it that the nerve may feel it. And when we find the transparent skin just over the pigment-spot thickened, so that it forms a little lens, or burning-glass, by which the light is gathered together and focussed on the spot, then we feel still more sure about our guess. But such an eye cannot see, for sight is not the perception of light, but the perception of other things by means of light. The condition of an animal endowed with such an eye as this must be very like the condition of men we meet with, who have gone blind, but can still tell night from day, or find their way to an open door in a dark room. And this is sufficient for the needs of jelly-fish; nor has it

mind enough to turn more than this to account. But let us follow Life, as it is called, to higher and better things, and we shall find the powers of this simple instrument expanding in the most wonderful way with each advance in the capacity to use it. The father gives his child a coloured chalk and a half sheet of note-paper that he may scrawl a four-legged table and call it a horse. Afterwards he has a shilling box of paints and a penny brush. But wait. The day will come when the sable must be hunted to find hair for his brushes, and when the making of his colours will be itself a high art. So it is with the eye.

The eyes of insects

But when we come to insects, a strange thing appears. Many of them have two kinds of eyes. On the top of the head are three small ones of the common pattern, called 'ocelli,' for which we must look with a magnifying glass; but on the sides of the head, and constituting more than half of it, there is a pair of enormous eyes, constructed on a totally different plan. They consist of bundles of minute tubes, bound together into one instrument, but each acting by itself. Each of the tubes is itself a most wonderful and complex thing, and in the eye of a common dragon-fly there are said to be no less than 2,000 of them. To get an idea of the working of such an instrument we may imagine a thousand telescopes,

bound together into one frame, but each pointing at a different star in the sky; or, say, not a thousand, but many thousand—one, in short, for every star. Then, if we can conceive one being looking through all these telescopes simultaneously, we can see that he would have a complete view of the whole heavens. Of course, a butterfly does not want to look at the heavens, and its eyes are not astronomical telescopes. What their actual powers are we have no means of knowing, except by watching insects and drawing inferences from their actions. A dragon-fly hawking small flies over a pond, or a hawk-moth darting from flower to flower and thrusting its long proboscis into each in turn, proves beyond doubt that, up to a distance of a yard or two, it can see the exact position of very small things correctly and clearly. And I have seen enough to satisfy me that butterflies know their own kind by sight at a distance of a good deal more than a yard. Crabs, which have eyes of the same kind, see me at a distance of many yards, and dart into their holes. But it is quite likely that insects see much further than a few yards in a less distinct way, as we see distant hills but cannot make out the objects on them. So a bee may be able to make out a flowery meadow a long way off; when it has got to the meadow it will distinguish the flowers. Then,

what is the use of the little ocelli on the top of the head? It is very difficult to say; but we have some materials for a guess. Butterflies are not furnished with them, while the larvæ, or grubs, of insects generally have them only. Bees and wasps have both. Now, a caterpillar does not need to see much beyond its own nose, but when it becomes a winged thing it requires a more extended view. A bee flies abroad, like a butterfly, but also works at home, in dimly lighted cells. So we may surmise that the little ocelli on the top of an insect's head are like the spectacles which a man carries in his pocket and puts on when he wants to read. This provision of two sets of eyes is confined, let me say, to insects and crustaceans (crabs, lobsters, &c.). When we come to the vertebrate plan, on which the four highest classes of animals (including ourselves) are constructed, we find that the compound eye is discarded, and a greatly improved form of the simple eye serves all purposes. This is found in its perfection in man, and we must linger to look at it.

CHAPTER IX

THE HUMAN EYE AND ITS USE

THE general plan of the human eye is almost the same as that of a photographer's camera. Its essential parts are a dark box, a lens and a sensitive plate. The box is not square, but globular—a very material difference—allowing it to turn freely in its socket. It is made of an opaque white substance, but across the front of it is stretched a dark and beautiful curtain, which is covered and protected by a transparent shield, like a watch-glass, known as the 'cornea.' In the middle of the curtain is a small round hole called the 'pupil' of the eye. A delicate, self-acting muscle controls this hole, and regulates the amount of light that enters the eye. If you look at the eye of a person who has just got out of bed, or come out of a dark room, the pupil will seem large, but before he has been many seconds in bright sunlight it has shrunk to the size of a pin's head. Just behind the pupil is the 'crystalline lens,'

A camera

not made of hard glass, but of a clear, elastic substance; for there is a contrivance here which the photographer cannot attain to. When he desires to focus his camera, so that the image may fall clearly on the sensitive plate, he has to do it by drawing out, or pushing in, the back of the box; but in the eye this is managed by a muscle which encircles the elastic lens and alters its shape and focus instantly, according to the distance of the object to be seen. As old age advances on us, the lens loses much of its elasticity, growing hard, so that we can no longer focus it for very short distances, but have to hold a book at arm's length, or help ourselves with spectacles. The inside of the eye is not filled with air, like a camera, but with a clear fluid. At the back is the sensitive plate. It is not a changeable plate, however, but a permanent membrane, lining the back of the eye-chamber and stained dark with pigment. On this the image falls; and here the analogy with the camera ends.

The photograph

For the image which falls on the photographer's plate produces certain chemical changes in its substance by which it is permanently imprinted there; and the same plate can never be used again. But on the retina of the eye an image falls for an instant and passes away, leaving it unchanged and as fresh as ever for the next and the next; yet during that instant a copy has been

taken in the dark developing room of the brain, which will remain for a lifetime. For a nerve from the brain goes to the eye, and, penetrating into it, spreads over the sensitive membrane and telegraphs to the brain every light and shade, every tint and hue, that falls there. What effect the image has on the membrane and how the nerve takes it up is all mystery still, as in the case of taste and smell and hearing. Indeed, it is in some respects more mysterious than these. A million rays of light—that is to say, lines of ether-motion—reflected from clouds and hills and trees and blades of grass enter the little hole in the curtain of the eye and are collected by the lens into a very small space on the retina. Each of these, presumably, is received by an infinitely fine nerve fibre, or some exquisite instrument with which the fibre point is furnished, which telegraphs to the brain its force and quality. In the brain the exact position of each nerve point must be known, for, though they all flash their messages simultaneously, each is instantly assigned its place, and the whole combination mapped out before the mind. (The image on the retina, as we have seen, is upside down, but this is righted in the mapping out.) The quantity of light received by each nerve is also registered, as brightness or darkness, and the number of waves per second is translated into those sensations which

we call red, blue, green, etc. And this becomes in the mind a beautiful landscape!

But someone will say, 'The image which is thrown on the retina is a flat image. How is it that the landscape which we see is not a flat picture, but has distance and perspective?' Well, I believe that at first an infant does see only a flat picture. The discernment of solidity and perspective distance is part of that education in the interpretation of our sensations which begins on the day when we come into the world, and ends on the day we leave it. We are apt to think of a newborn infant as a perfectly inert and passive little being, which lies on its back and does nothing. This is just the reverse of the truth. Never in after years, at school or college, will it apply itself to its studies as it does during that first year. Dr. Livingstone tells us that, shortly after arriving in Africa, he went to a place called Lepelole and cut himself off from all European society for six months, that he might learn the ways of thinking, laws and language of the Bechuanas, among whom the work of his life was to be done. So it is ordained that, when we first enter into this world, where each of us has an appointed work to do, we shall be laid on our backs for a season and absolved by helplessness from all other concerns, that we may master those

Learning to use the eye

five languages through which we must receive all the knowledge that we shall ever have of the being and working of the things among which we live. Everything that passes sends messages of light into those blue windows, so wonderingly open, but the owner of the house does not know what they mean, and there is no interpreter. He must learn as Livingstone did. It is very difficult to imagine how the first words are picked up, how he gets at the first notions of light and shade and position and colour ; but, that done, it is easier to understand how he progresses. We have seen already that the eye is focussed by a little muscle which em-

Measuring distance

braces the lens. Every time you look from one object to another that delicate muscle comes into operation, and though its action has become quite automatic and unconscious long before the age at which memory begins, the degree of effort which it has to make before a thing comes into clear vision is a measure of the distance of that thing. A very good practical lesson in the use of this muscle is to look at any distant object through a railing, then look at the bars of the railing, and again at the object. But there is another measure ; for we have two eyes, and they work together. If you hold out two fingers, so that the points are just as far apart as your two eyes, it is evident that, if your eyes looked straight forward,

each of them would be looking at a different finger. But they do not look straight forward. Both of them look at either one finger or the other. To do this they must converge, or turn towards each other, and we find that there is a muscle provided for this purpose. Now it is evident that they must converge more to look at a near object than at one which is far away. This is the second measure of the distance of an object. In fact, every time we look at any object we are taking angles and measuring its distance on a principle not different from that on which the astronomer measures the distance of the moon. But both these measures serve only for short distances. When things are far away the difference of the angle of convergence is too small to be felt, and we are obliged to guess at the distance of things by their apparent size and by the extent of ground which seems to lie between them and us. Our skill at this kind of guessing varies much with the practice we have had. A sportsman can tell the range of his game with an accuracy which surprises the tyro, and a sailor makes fun of a landsman trying to guess the distance of objects at sea. Things up in the air puzzle us all, because there is nothing between to guide our judgment. A threepenny piece held at arm's length, a saucer at ten yards' distance, and the moon 237,000 miles away, all cover about the same

space on the retina of the eye. We know the size of the saucer, and so it appears that size to us; but it is evident that the apparent size of the moon must be just what each man fancies it for himself. And if you question your friends you will find the most amusing differences of opinion as to how large the moon really 'looks.'

Perception of solidity

So much for distance. Next, it is evident that nothing can appear exactly the same to both of our eyes, since they are looking at it from different points of view. If you hold a shilling straight in front of your nose, with the edge turned towards you, the right eye will see one side of it and the left eye the other. If you hold an apple in the same position, both eyes will see the front of it, but one eye will see more of one side, and the other more of the other. So every solid thing we look at is presenting slightly different pictures to our two eyes; only a flat surface can be the same to both. But we are not aware of this; we have learned to combine the two pictures instantly and unconsciously, and out of them to construct the idea of a solid thing. How we learned this is told so prettily by Helmholtz that I will quote him instead of trying to tell it myself: 'The infant first begins to play with its hands. There is a time when it does not know how to turn its eyes or its hands to an object

which attracts the attention by its brightness or colour. When a little older, a child seizes whatever is presented to it, turns it over and over again, looks at it, touches it and puts it in his mouth. The simplest objects are what a child likes best, and he always prefers the most primitive toy to the elaborate inventions of modern ingenuity. After he has looked at such a toy every day for weeks together, he learns at last all the perspective images which it presents; then he throws it away and wants a fresh toy to handle like the first. By this means the child learns to recognise the different views which the same object can afford in connection with the movements which he is constantly giving it. The conception of the shape of any object, gained in this manner, is the result of associating all these visual images.'

The invention of the stereoscope put an end to any doubt which there might have been that our conception of solidity is got at by combining the sensations of the two eyes. A stereoscope slide consists of two photographs of the same view, at which we look through two magnifying glasses, with a partition fixed between them, so that each eye sees separately the picture which is in front of it. When we look in this way, instead of seeing two pictures, we see one scene standing out with a solidity and vividness which is unattainable in any

picture. The reason is that the two pictures on the slide are not copies of the same: they are photographs of the same house or place, but taken from slightly different points of view, one a little to the right and the other a little to the left, just as our two eyes would look at it. Now we see the use of having a pair of eyes. It is not just to make our faces symmetrical. We might have had one eye in the middle of our foreheads, like Polyphemus, and looked very impressive, but we could not have seen as we do now. Not that it is impossible to arrive at the idea of three dimensions with one eye. An artist contrives to present that to us in a picture, which has only length and breadth without depth. But the most perfect picture is never quite the same as reality seen with two eyes.

Here let us note that the power which our eyes possess of working together, and combining their images, results from their position in the front of the head. In most animals the eyes are situated more or less on the sides of the head, and in proportion as this is the case must they work separately, each presenting its own hemisphere to the mind. A horse ordinarily sees the objects on its right side with one eye, and those on its left with the other; but when it is particularly interested in anything it turns its head, so as to get the thing straight in front where both eyes can bear on it at

once. But a duck's eyes are quite on the sides of its head, and cannot both be turned on any one point, so it presents the side of its head at you and takes you in with one eye. I suppose that it simply neglects the other eye at the time, concentrating its attention on one. But in the chameleon the eyes work independently in their sockets, so that while one is scanning you on the right, the other may be following the movements of a fly on the left, the mind of the creature oscillating, no doubt, between fear and greed.

Looking

I have spoken several times of 'looking' at things; but what is the meaning of 'looking'? The question reminds me that in describing the eye I passed by a very important point. The retina is not uniform, like a photographer's plate. The uniformity is broken at two points, known respectively as the 'black spot,' or 'blind spot,' and the 'yellow spot.' The black spot is where the optic nerve forces its way through the back of the eyeball into the interior of the eye. This part is quite blind. There is always, therefore, a place on each side of us which is only seen by one eye, and which disappears entirely if you close that eye. It is easy to get anything, a friend's head, for example, into this place. Stand about three yards from him, close your left eye and let the right wander from his face to the leftward;

when it is looking nearly a yard to the left of him his head will disappear entirely ; look a little more to the left and it will come into view again. It is surprising that we may live a lifetime without discovering this defect. It was first brought to notice, I believe, by Marriotte a little more than two hundred years ago.

The blind spot serves no purpose. It is merely a result of the way in which the eye is constructed. So we have no further concern with it. With the yellow spot, which is a little to the outer side of each eye, we have every concern ; for the yellow spot is to the rest of the retina what the finger-tips are to the rest of the skin. At that point only do we see distinctly, and looking at a thing means turning the eye and focussing the lens so that the image of the thing shall fall exactly on that spot. When we admire a landscape we are apt to imagine that we are looking at the whole of it, but we are doing nothing of the sort ; we are looking at one point of it, and that we see distinctly, but the rest is more or less a haze. It is not only a haze, but a double haze. A moment's consideration will make this clear. Hold up a finger between you and any distant object, say a tree. If you now shut the right eye you will see the tree far to the left of your finger, but if you shut the left it will go to the right of your finger. It is clear, therefore,

that when both eyes are open and looking at the finger, they must see the tree double. We are perfectly unconscious of this, because we are not looking at the tree, but at the finger. If we think of the tree, both eyes are bent on it in an instant, and it stands out single and distinct; and now the finger is double, but we do not notice that. So when we look at a landscape, only one point of it is distinctly seen by us at a time, but the eye follows the thoughts so nimbly, presenting instantly and clearly each object to which we turn our attention, that the whole view is kept vividly before the mind. Then what is the use of the rest of the retina? It is a spider's web, spread to catch passing flies. It takes in nearly a hemisphere of earth and sky, and if anything unusual, or anything which specially interests us, crosses the field, the attention is attracted, and at once the eye turns on it unbidden; for one of the first lessons the eye learns in infancy is to follow the attention. When you drop any small thing on the carpet, if it is bright, or very different from the colour of the carpet, or if it moves, the image of it, falling on any part of the retina, is sufficient to excite the attention, so it 'catches the eye' at once; but if it is much the same colour as the carpet, you look for it, that is to say, you let your eye wander over the carpet until the thing chances to cross the sensitive

spot. When the eye turns on a thing, it focusses itself at the same moment, so as to bring that thing into clear definition. The direction in which it has to point fixes the situation of the thing with respect to ourselves, the view presented by the rest of the retina is clear enough to fix its situation with respect to other things, and its distance from us is measured in ways already described ; so we know *where* it is. Then the two eyes, working together, define its form : it is compared with the prints stored up in the brain of things we have seen before, and we know *what* it is. Else, if we have not seen that kind of thing before, we take a print of it that we may know it again. Or it may seem very like something that we have seen before but different. In that case the eye wanders over it, noting the features of difference and taking a print of each of them.

Considering these things, it seems to me that the usefulness of a man's eyes depends mainly on the clearness and the permanence of the photographs that he takes with them ; and the permanence depends mainly on the clearness, for ill-defined and hazy impressions will soon fade away, but sharp and clear-cut lines will remain in the memory for ever. No doubt this has as much to do with the mind as with the eyes, for the precision and vividness of our impressions of things will

Discriminating

depend on the *attention* which we have given to them. The eye is only the instrument of the mind. Yet there is a difference in instruments. As some eyes see further than others, and some can see smaller things, so some can detect fine shades of colour and slight variations in form which are imperceptible to others. And this power is improved by use, just as the ear of a musician is. In this lies one of the great benefits we reap from the study of botany, or any branch of natural history. It trains the eye as nothing else does to detect differences and recognise resemblances, in short, to *see*. For these differences and resemblances exist; every one of them is a *fact*, with its own import; but the unskilful eye does not see them. The practice of painting also trains the eye to detect effects of light which the unpractised can scarcely discern even when they are pointed out to them.

Observing

There is another quality which seems to contribute to the usefulness of a man's eyes even more than those I have mentioned; I mean the quality we call sharpness. Some men appear to notice everything, others nothing. But this, also, is largely a question of the wakefulness of the mind. One man's mind is always on the watch-tower, looking out, and nothing escapes it; another's is drowsy, or perhaps is looking inwards, too much engrossed with the high and deep things

of its own consciousness to be diverted by impressions from without. Archimedes, sitting in his study at Syracuse, was so much absorbed in some mathematical problem that he did not know when the city was taken. But even in this case there is something, nay much, in the eye itself. Some eyes, by nature or habit, are very much more sensitive than others, so that they are 'caught' at once by things which fall on others without effect. And by training this sensitiveness may be wonderfully increased, not only in a general way, but with reference to any particular class of impressions, so that a man comes to notice with incredible sharpness anything connected with a favourite pursuit, while he remains comparatively blind to other matters. A botanist's eye is caught by a little wayside flower; a naturalist is started out of the current of an absorbing conversation by a bird that flew swiftly past him; and a lady, passing a friend (or rival?) in the street, takes in at a glance almost every detail of her dress. This last seems, to the male mind, the most wonderful example of all; for a man, if he gave his whole attention to it, could scarcely in so short a time do more than gather as general impression of the colour of the costume, and would forget the bonnet altogether.

The same acquired sensitiveness to a particular class of impressions in the sense of hearing is a

matter of familiar observation. In a babel of noises one faint sound, be it a note out of tune, or an infant's cry, or the tone of a loved voice, will startle one ear and no other. It is so with all the senses. And it must be so. For the world is full of existences and activities of which no finite capacity can take in more than an infinitesimal portion ; and each must concern itself with that portion which concerns it. It must seek those things which are needful for its body, that it may live and be strong, and it must watch against those things which would destroy it. Next, it has to seek and find its own kind, and next (if that privilege and responsibility has been committed to it) it has to give heed to those things which concern the welfare of its offspring. And so, like a busy man of affairs, who, among the hundreds of suitors that are knocking at his doors, admits those with whom he has business, each living creature in this world has to open its doors to those things that concern its well-being, and shut out the rest, as far as it can. And the doorkeeper's name is Attention. The tiger, as it prowls through the jungle, has no ears for the voices of the birds, nor eyes for their forms ; it never looks up. In Western India it is commonly shot from a ladder resting against the trunk of a tree. The sportsman sits on one of the rungs of the ladder, and it will pass

within a few yards and never see him. But for every object on the ground, for the lightest footfall, for the faintest odour, how wakeful are all its senses. Contrast with this a partridge feeding in a stubble field, with her brood about her—she seems to be engrossed with humble matters of the earth. But a shadow on the ground, or a speck in the sky, will startle her out of her engrossment, for a hawk is one of the great concerns of life to her. So is a fox, or a wild cat ; and the ears of the partridge are very tender to the sound of rustling grass ; the tread of a cow is many times louder, but it does not scratch her nerves in the same way. So every weapon is sharpened to its own particular use and by its own particular use. I have often noticed the quickness with which a bee-eater, sitting on a telegraph post, will notice a passing fly fifty yards away. The eagle on his crag sees no flies, but his keen eye is instantly caught by a dark speck that *moved* on a distant hill-side. The vulture, sailing among the clouds, has all the world and its moving things spread below him, but notices only a dark object in the dim distance which *does not move.*

CHAPTER X

COLOUR

So far we have thought of sight with reference only to the forms, sizes, and situations of objects ; and we may reflect that this might have been all. The world might have been colourless, and all the things we see like the objects in an engraving. But it has been ordained otherwise, and the colours of things are a great help to us in distinguishing and recognising them. They are far more than this, for colour ministers half, nay, much more than half, of all the beauty with which the world is clothed to our eyes. But we shall come to that by-and-by. In the meantime let us consider for a little this mystery of colour. It is a mystery. We can find no reason why some substances should reflect those rays of light which vibrate at a certain rate, while other things absorb these and reflect those which vibrate at a different rate. Some substances are heavier than others, some are harder, some are more soluble in water, and there are many other qualities in which one

substance differs from another; but these seem to be inherent qualities of the substance in a sense in which colour is not. We can find no connection between the colour of a thing and the nature of its substance. In fact, in the case of living things the colour has often nothing to do with their general substance at all, but results from a minute quantity of something which we are forced to call 'colouring matter,' which appears to have scarcely any other function but to deal in a certain way with the light that falls upon that thing. The green of fresh leaves, the tints of flowers, the colour of our own hair, the hues of birds and butterflies, all result from some such pigment or colouring matter; so that we may say that nature has dyed these things just as we dye our clothes. And here another strange fact appears, which is this, that the production of the dye often depends upon the action of light. Leaves are green because their tissues are interspersed with minute granules of a green substance to which the name of *chlorophyll* has been given. But these granules are not produced except under the influence of solar light. It is a familiar fact that plants kept in the dark rapidly get bleached, and we cover the stalks of celery with earth in order that they may grow white. But let that pass for the present. The fact with which we have to do just now is that

all things, living or dead, make a selection from the light that falls on them, and the balance, which they reject, or reflect, is their colour. But if this is the meaning of colour, then every hue and tint that the face of the world shows must be contained within the compass of the rainbow. And it is so, as we shall see. We are accustomed to speak of the 'seven colours' of the rainbow, and generally by the names which Sir Isaac Newton gave them—namely, red, orange, yellow, green, blue, indigo and violet. But some of these are obviously blends of others; we can make orange by mixing red and yellow. This was observed long ago, and the old artists decided that there were only three primary colours—red, blue, and yellow—by mixing which all the rest could be produced. It is now generally agreed that this was a mistake. It resulted from confounding the mixing of *colours* with the mixing of *paints*, which is a very different thing. We can mix *colours*, that is, *coloured lights*, in several ways. The easiest is to paint two colours on a circular piece of cardboard and spin it on a top. The colours are thus perfectly blended to the eye. Experiments conducted in this and other ways have led to the conclusion that the three really primary colours are the two at the ends and the one in the middle

Colour is rejected light

All the colours we see are compounded of three

of the spectrum—namely, red, violet and green. However, we need not go into that question here. It is enough to say that by blending lights of these colours we do get all the intermediate hues, and by blending the two at the ends, red and violet, or red and blue, in different proportions, we get all shades of purple, a colour which is not in the spectrum at all. But there still remain two whole classes of colours which cannot be got in this way—the pale tints, pink, emerald green, pale blue, or 'French grey,' and so on, upon the one hand; and the dull greys and browns upon the other. In painting we make these by mixing white with our colours for the one class, and black for the other; and nature has the same resource. For white is only entire light, and black the absence of it. So, if an object reflects one half of the light that it receives in an entire state, and the red rays of the other half, the result is pink; but if it absorbs one half and reflects the red of the rest, the result is brown. If half is absorbed and half reflected without distinction of colour, the result is grey. Painters sometimes produce these effects, not by mixing, but by laying one colour in minute dots or lines on a ground of another, so that the two are blended to the eye at a little distance. A few small dots of pure red will make white paper look pink, but give a brown tinge to

black paper. The colours of cloth are very often produced thus, and there is, in short, no limit to the hues and tints that may be obtained, in this and other ways, simply by blending the three primary colours of the spectrum and black and white.

We may notice parenthetically here that the spectrum is not the whole of a beam of sunlight, but only so much of it as *we can see*. Beyond the red there are rays which we cannot see with our eyes, but which we can feel with our skins as *heat*; and beyond the violet there are rays which we cannot perceive with any of our senses, but which are easily detected by their chemical effects. Now we know that some men cannot see the whole spectrum. They are called 'colour blind' persons. From five to ten per cent. of mankind (a far smaller proportion of womankind) suffer from this defect, though they are generally quite unconscious of it. The commonest form of colour blindness is insensibility to red. To persons so affected all red objects look dusky or green, and they seldom discover that such objects present a different appearance to other people. Now, just as the rest of us have a power which these persons have not, so there is nothing to forbid the notion that some animals may have a power which is wanting to us. Indeed,

There is more than we see

it would be rather strange if the limits of vision were everywhere the same. So it occurred to Sir John Lubbock to make experiments on ants, with a view to find out how they are affected by the different colours of the spectrum, and he made the remarkable discovery that they have a strong dislike to those ultra-violet rays of which we are quite unconscious. It does not necessarily follow that they perceive these with their eyes; but, supposing they do, then they see a colour in the rainbow which is not in our scheme of colours at all, and which it is, of course, impossible for us to think of. Not only so: this colour must be an ingredient of all white light, *as they see it*, and of many compound colours; so the whole aspect of nature must be different to their eyes from what it is to ours. And when we consider the matter rightly, there is no reason to suppose that things look the same to a bird, or a butterfly, or to any other animal, as they do to us. But this makes little real difference. Just as many nations read the Bible, each in its own tongue, so the book of nature is read by many races, each according to its own eye. But in the one case, as in the other, the meaning is the same to all, whatever difference there may be in the symbols through which it is apprehended by the mind and heart.

To return to our own eyes, there is no secret

which men of science have laboured more painfully to penetrate than the question by what means the different sensations which we call colours are produced in us. In the ear, as we have seen, there is a wondrous harp of many thousand chords, and we can well imagine that every possible tone within the range of our hearing finds some chord to vibrate in harmony with it. But no such instrument has been found in the eye. The theory most in vogue is that of Young, which assumes that there are in the eye three kinds of nerves, or rather of nerve points, which are responsive to the vibrations of the three primary colours. When one of these is acted on alone, it produces its own peculiar sensation; but when two are acted on at once, an intermediate sensation is produced; and when all are acted on simultaneously, the result is that complete sensation which we call *white*. There is no denying that in the hands of ingenious men this theory has been made to explain almost all the phenomena of vision in the most remarkable way. But nobody has yet been able to distinguish three sorts of nerves in the human eye, and for my part I find it hard to believe that all our unnumbered sensations of colour, tint and shade are arrived at by nicely weighing the proportionate degrees in which three nerves are tickled. Aubert came to

The mystery of what we do see

the conclusion, after numerous experiments, that the eye (I suppose he meant his own eye) could distinguish at least one thousand shades of colour in the spectrum. Add to this the differences which we can make by adding various quantities of black and white to each of the colours, and the different degrees of brightness which plainly result from more or less light, and it is evident that the eye has a far greater range of sensations than even the ear. Can we imagine a cook supplied with three condiments, salt, pepper and vinegar, and combining these in various proportions to make us believe, according to his pleasure, that we are eating beef, bacon, pheasant, plumcake or pine-apples, or any of ten thousand other things? Surely it is better to say simply that we know nothing about the matter. The like mystery meets us in the cases of taste and smell, and we have to do without a theory, for nobody has found one that will work. But the sense of sight is beyond all comparison more wonderful in the multiplicity of its perceptions than either taste or smell. Not only can we distinguish a thousand, or many thousand, tints and shades of colour and degrees of brightness, but we can detect the most subtle differences between the ways in which the surfaces of various substances reflect the light that falls on them. Polished surfaces reflect the light

in a mass, as it came, and flash in one direction only. Rough surfaces break it up and scatter it in all directions, but with differences according to the nature of the roughness. The eye detects these differences most minutely. A handkerchief, a sheet of paper and a China plate are all white, but they are as plainly distinct to the eye as if they were red, blue and green. We can tell almost infallibly whether a thing is hard or soft, and define its texture and substance, by the look of it, that is to say, by the way in which its surface plays with the light.

The perceptions of the eye are comparative

One thing, however, must be noticed here, namely, that the judgments of the eye are *comparative*. It measures differences and contrasts with marvellous nicety, but can form little estimate of the actual quantity of light that comes from anything. For example, grey is just diluted white, and the difference between grey and white paper in the light of the sun is just that one reflects only half as much of it as the other. Now, if the white paper is placed in moonlight, which is 400,000 times weaker than sunlight, it will reflect very much less light than the grey paper did in the sun, and it ought to look dark grey. But it does not; it looks white still, because we do not, and, in fact, cannot, judge it as it actually is, but only by com-

parison with the other things about it. In this respect the eye is like the ear, which can judge so nicely every note of a tune in its relation to the first note, but cannot fix the pitch of the first note without the help of a tuning fork. Even, as regards colour, the eye is incompetent to form an independent judgment. The colour of all the things in a room is affected by the colour of the walls and carpet. Every artist knows this, and every lady. If we think of these things as defects of sight, we shall think wrongly. That is not a defect in any instrument which makes it more fit for its purpose, and the eye is not a photometer for measuring light, but an instrument by which we are to recognise objects. If it took account of every variation in the quantity or colour of light, snow would be one thing in sunlight and another on a cloudy day ; but the eye makes unconscious allowance for what is variable, and affirms the spotless whiteness of snow in sunlight, moonlight, or lamplight. It is subject to illusions, no doubt, many and curious ; but they are such illusions as we are subject to in everything when we meet with unusual conditions, and judge of what we do not know by what we know.

For, I say again, we must never forget that the eye works by experience. All through life, to our dying day, we are laying up knowledge of appear-

ances, or, to speak more correctly, of sensations. A city boy, who has never seen water except in a bucket, or as rain falling from the sky, or gushing from a spout and running muddy down the roadside gutter, will not know it for water when he first beholds it in the ocean. I knew a boy who described the sea, at his first sight of it, as a great meadow covered with clothes-lines and all the white clothes flapping in the wind. And when one has seen water under almost all possible conditions, so that he can never mistake it again wherever he meets it, there may still be in store for him many fresh experiences of its effects in new and beautiful combinations. Nothing else that we have ever seen was exactly the same as the following sublime picture; but every separate element of it is registered somewhere among our past impressions, and so we have no difficulty in realising it in a measure:

The eye grows in knowledge

> The roar of waters! from the headlong height
> Velino cleaves the waveworn precipice;
> The fall of waters! rapid as the light,
> The flashing mass foams, shaking the abyss;
> The hell of waters! where they howl and hiss,
> And boil in endless torture; while the sweat
> Of their great agony, wrung out from this
> Their Phlegethon, curls round the rocks of jet
> That gird the gulf around, in pitiless horror set.

Horribly beautiful ! but on the verge,
From side to side, beneath the glittering morn,
An Iris sits amidst the infernal surge,
Like Hope upon a deathbed, and, unworn
Its steady eyes, when all around is torn
By the distracted waters, bears serene
Its brilliant hues with all their beams unshorn ;
Resembling, 'mid the torture of the scene,
Love watching Madness with unalterable mien.

By the time childhood and youth have got behind us there are few new effects of light for us to learn, and it is not to look for such that we wander over the earth, lovingly gazing at its face on all sides and under all skies : it is to feed the eye on old effects in new and beautiful combinations. And yet in the old there is always something new ; for the eye grows keener by exercise, and sees things that it never saw before. And this brings us to another stage of the subject.

CHAPTER XI

THE PLEASURE OF SEEING—BEAUTY

'TRULY the light is sweet, and a pleasant thing it is for the eyes to behold the sun.' We are accustomed to think of the sun as the great source of heat and life; but I do not think we give it its due as a spring of happiness. What a flood of half unconscious joy it is continually pouring down upon this world. We feel it after we have been deprived of the cheering influence for a time, when the clouds clear away, and all things are bathed in brightness—

> While the birds thus sing a joyous song
> And the young lambs bound
> As to the tabor's sound.

But at other times—at all times—there are more gentle influences which escape our notice. The coloured lights from sky and plain play upon our eyes as the soft breeze plays with our hair, and our changeful moods are stirred or soothed. But this, which I believe all animals feel in common with ourselves, is quite a different thing from the sense

of beauty, of which it is now time to speak. The one is a sensation of light ; the other is the perception by light of some quality in material things which we know by the pleasure that it is capable of giving us. We call it by many names—beauty, loveliness, grace ; but what is it ? There are two distinct elements in beauty, of which one belongs to form and the other to colour. Let us begin with form, for it is the easier to understand.

Beauty in form. Geometrical forms

I suppose I need not go about to prove that the first element, the first letter in the alphabet, of beauty in form, is a straight line, the 'shortest distance between two points' and the path of motion. The next is the relation of straight lines to one another, as parallels, which are at all points equally distant from one another, so that, if infinitely produced, they will never meet ; and as perpendiculars, when one line meets another so that the angles on both sides are equal. Squares and all rectangular figures are combinations of parallel straight lines, and we need only cast our eyes round the room in which we sit, or look down the street in which we live, to see how our whole life is framed with these figures. The eye demands it. Who could endure a book in which the lines of print were not parallel, or eat his dinner at a table the sides of which were just a little off the square ? How it takes away a

civilised man's appetite when a servant who is not gifted with a 'straight eye' lays the cloth askew, and the plates at irregular intervals! And this leads to the remark that the eye for a straight line, like the ear for music, is a gift. Some have it in a far higher degree than others, and some (happily few) appear to be born without it. More of that by-and-by. Straight lines which are not parallel may form a figure that is pleasing to the eye, if there is a law in their relationship; for example, a triangle of which at least two sides are equal. The roofs of our houses are designed on this figure. Next comes the curve—not any curved line, but the perfect curve—which, if produced, will come back to the point from which it started; the circle, in short, of which every point is equally distant from the centre. Here we may stop, for these simple figures embrace as much as a large majority of mankind can see. This has often struck me when watching the work of a gardener in India. He will lay out a plot of ground in circles and squares, arranged with perfect symmetry round a common centre; and if he is an exceptional genius, he may rise to stars, which are a combination of the circle and the triangle. But we are not satisfied with this: we say it is too regular, prim, stiff. So we sweep away his neat figures and introduce uneven divisions and wi nding paths, to produce effect

which we call graceful; but to him they are simply chaotic. And if he tried to imitate them, the result would indeed be chaotic; for, discerning no law, he would follow none. What, then, is the law that we follow? We may not be able to say, for our perceptions are far ahead of our science. We discern beauty, as we discern harmony in music, by sense, the judgments of which are independent of our ability to give a reason for them Yet I take it for certain that, in a garden, or any design which is felt to be tasteful, every curve and every figure, if measured, would be found to be definable in mathematical terms.

It would also be definable in terms of motion, for all motion under law, that is to say, all motion which results from two or more forces (one force can only produce motion in a straight line) bearing a fixed relation to each other, must work out a true mathematical curve. Here is the secret of that connection which every artist feels between grace and motion. Let me use an illustration to make it plainer. If you take a pair of compasses, fix one leg and make the other revolve round it, you will describe a circle. But suppose you cause the legs to open slowly as the compasses revolve, then each circle will end wider than it began, and you will describe a spiral. A true spiral is a beautiful figure; but note that to

Grace and motion

get a true spiral you must fulfil two conditions: you must make the compasses go round at a perfectly uniform rate, and you must make them open at a perfectly uniform rate. Any irregularity in either motion will inevitably spoil your spiral, and the eye, knowing nothing of how it was produced, will condemn it as an 'irregular' and unsightly thing. Or consider a skater cutting figures on the ice. As he spins round in a circle he is working with two forces, centrifugal and centripetal. His impetus would carry him on in a straight line, but he counteracts it by throwing his weight a little on one side. If he balances these two forces exactly he will cut a circle on the ice; if he lets the centrifugal preponderate slightly he will cut a spiral. Whatever he does, if the two forces work uniformly, the result will be a true figure. This is not strictly correct. It is not the forces that must be uniform, but the ratio between them. His rate of motion diminishes rapidly as the impetus with which he started gets spent; but if he can change the inclination of his body in a corresponding degree, this will not affect the figure. To me a sight like this is an ineffable wonder. Here is a human body, at the bidding of a human will, committing itself to the eternal and immutable laws which guide the planets and the comets in their various courses through trackless space; and

the result is beautiful. And how is it attained? Not by tracing a figure and following it; not by looking at all—the skater scarcely sees his figure till he has finished it; he is guided by that inward 'muscular sense' which I described in the chapter on the sense of touch, which measures at every instant the exact poise of his body. And by that same sense he experiences a thrill of keen delight as he executes each perfect movement; while we, by another sense, enjoy a kindred delight in the contemplation of it. What an emblem might a prophet find in this of a human soul committing itself to the 'perfect law of liberty' and leaving a track on time beautiful to men and angels.

But this is a digression. To return to my argument, as long as the skater preserves a uniform ratio between the two forces which decide his direction, he must describe a true mathematical figure; and the eye discerns the fact in two ways, in his action and in the result on the ice. Let him lose his balance ever so little, and the eye will detect both a lapse of grace in his action and a flaw in the figure which he cuts. These two things are not separable, though we may see only one of them at a time. When we watch an eagle sailing in the air, we admire the grace of its motion, though it leaves no record of its path. On the other hand, when we admire a 'line of beauty' in

art, we see no motion ; but we may rest assured of this, that it is such a curve as might have been traced by graceful motion, else it would not be beautiful.

Note also that in all grace there is economy of force ; every lapse from it marks waste. How often we see this illustrated. Two racers, on horseback or bicycles, have to round a post. One estimates his impetus to a nicety, calculates the least space in which it is possible for him to turn, begins at the right moment, slackens speed just enough, and rounds the post in a perfect curve, not necessarily a semicircle, more probably a parabola, with the post for its focus. The other miscalculates, passes the post sooner, but is carried too far on the other side, and has to check his speed suddenly and correct his curve, losing a good deal of his momentum. What the onlookers notice is the failure of grace ; but the practical result is a loss of fifty yards in the race. Here lies the reason why the feats of a skilful acrobat are always so gracefully performed ; he cannot afford to waste any of his strength in inelegant movements. And the birds which excite our admiration by the elegance of their motions are the acrobats of flight ; not the domestic fowl, but the eagle, the swift, the albatross. They do not aim at grace, but they cultivate the highest degree of speed and endurance, and grace

follows of necessity, for no one can do a thing really well who does not do it gracefully. It is only another aspect of the same connection that those things which are swiftest in motion are graceful in their forms even when at rest. In all the handiwork of man there is scarcely an object more elegant in every line of it than a racing yacht. But the man who designed it was not thinking of beauty. He was thinking of winning a race, and when he laid the 'lines' of its sides he had just one object in view, namely, to reduce to a minimum the resistance of the parting waters in front, and the suction of the closing waters behind. So he studied the inexorable laws of dynamics, and produced a form which charms the cultured eye. In this connection read again the description by Mr. Haweis of a Stradivarius violin, quoted in the chapter on Music.

But I need go no further. I have only been wasting time if the truth has not become luminous already that our sense of beauty is nothing else than a joyous perception of the lines on which this universe in which we live is planned. And without doubt that perception is first called into exercise by the necessity of conforming to those lines in our own works. The primary elements of beauty, those fundamental relations of space which it is the province of geometry to explore, are forced

upon the savage man as soon as he begins to construct, because he cannot construct anything at all without observing them. He chooses the straightest stick he can find for his spear, because experience soon teaches him that he cannot fight effectively with a crooked one. He builds his hut round or square, not because these forms are pleasing to him, but because he cannot make a stable hut of any other shape. He makes the walls perpendicular, because if he does not they tumble down. He makes his millstone as circular as he can, finding that only so will it go round smoothly. Then, out of the manifold application of these forms grows a sense of their inherent fitness, rightness, beauty; while by practice the eye grows more and more skilful to detect any deviation from them, and is offended by it. And how rapidly this perception, once awakened, outgrows its origin and discerns the same mystery of beauty in figures which have no relation, in his experience, to any use, and finally, in figures of which Nature presents no examples to his eyes, though they are being traced over his head continually by many a 'traveller that leaves no footmark.'

What beauty in form means

But in every work of art, be it the laying out of a garden, or the designing of a cathedral, or the arranging of a drawing-room, there is a great deal

more required than that each line and figure should be right in itself. It must also be rightly proportioned and rightly situated with reference to the rest. These relationships defy mathematical analysis, but the eye judges them, and its judgments are final. You hang up your picture and step a few paces back, and the eye says emphatically, 'Too high,' or 'Too low.' It vouchsafes no reason, except *Non placet*, and that is enough. You must change the hanging of your picture or offend every cultured eye that comes into the room. In this connection, however, there is one thing which must never be forgotten. The human mind cannot regard anything quite as it is in itself, and apart from the ideas which it calls up by association or suggestion. So it often happens that the perceptions of the eye (if I may speak very loosely) have to give way to the higher perceptions of the mind, and that which is inherently less beautiful becomes in the circumstances more acceptable. One example will suffice to make this clear. In furnishing a drawing-room it is evident that the most symmetrical arrangement would be to put your table exactly in the middle, and the chairs at regular intervals in a circle round it; or else, if the table is square, the chairs may be placed in a row, with their backs against the wall. Any books or albums on the table should be placed at

Complications

exactly equal intervals, parallel with lines radiating from the centre. And this is just the way in which a tidy and orderly servant, with taste cultivated up to a certain point, is disposed to arrange a room. But the mistress comes in, pronounces it horridly 'stiff,' and begins to pull the chairs about and disarrange the books. The explanation lies in the mind. The arrangement of chairs and tables which so displeases us may be formally perfect, but we do not want formal perfection in a drawing-room, because it suggests either an unoccupied house, or some kind of restraint. In a church or a schoolroom this is fit, but not in a drawing-room ; there we want to feel that there is life and freedom. If the chairs were all arranged with their backs to the wall, as I have seen them in the house of a native gentleman in India, nobody could resist the solemnising influence ; conversation would be quenched. So with the books on the table : a little disorder in the placing of them lets in the thought that they are and may be looked at. But such irregularity in the placing of the clock on the mantel-piece would be displeasing, because it is not meant to be handled. It is in the delicate perception of such suggestions and associations of ideas that what we call 'good taste' consists ; but a person who has this in the highest degree may not be able to give a reason for what

Good taste

he (or shall I rather say she ?) perceives to be right. This kind of taste, however, is quite outside of our immediate subject. In practice the two are often so blended that it is impossible to separate them ; but we must keep our attention for the present as strictly as we can on the perception of formal beauty and grace. This has its place even in the irregularity of a well-arranged drawing-room, and makes the difference between the purposeful want of symmetry which pleases us there and that purposeless disorder which betrays the abode of the untidy man, who leaves everything where he last used it. For seeming irregularity may be only a more subtle regularity. In the fair arrangement of a number of articles of different sizes and shapes there are laws of proportion just as definite, though by no means so obvious, as those which rule the simplest pattern of squares and circles. And because they are less easy to discern, they give the more pleasure to the eye that can discern them ; just as that music is most enchanting to the trained musician in which the common ear can find no music at all.

So far we have thought only of beauty in form, and, as I have said already, the world might have been colourless, and we could still have lived in it much as we do now and found it very beautiful. Very possibly it is colourless to

Beauty in colour

some animals, whose eyes may be constructed only to distinguish differences of light and shade. But the world is not colourless to us. Substance differs from substance with respect to the light which it absorbs and reflects, and to those animals whose eyes are sensitive to this difference, it is a great help in distinguishing and recognising objects. Bees know the flowers by their colours, and prefer those that are white or blue, having learned that these generally contain the sweetest honey. When Rip Van Winkle awoke from his long sleep he had only to lift up his eyes to know what season of the year it was. And at every step in our life colour helps us to recognise things more easily and certainly than we could do without it. But colour has the power to beget in the mind of man and beast and bird, and possibly creeping thing, something more than bare recognition. The peahen would know her mate from all other fowls by his long train, even if it were the colour of smoke; but when that train is spread to the sun in all its dazzling beauty, does she merely know him for her mate? She knows him for the most glorious being in all the world, one whom it is the peculiar bliss of peahens to follow and adore.

In the spring a fuller crimson comes upon the robin's breast;

and he becomes more lovely in the eyes of his

spouse, and she loves him more. And who shall say how much of that elation of spirit which we feel on a glorious day in spring is awakened by the magic influences which play upon our eyes from that mantle of beauty which colour throws over the world? It is like the sound of sweet music, making the blood course more gleefully through our veins. And, indeed, much that I have already said of music is equally true of beauty. If music is a power in love and war, what of beauty? Love cannot be disjoined from it in thought or language, while the warpaint of the savage and the uniform of the field-marshal are alike acknowledgments of its influence on those feelings and passions without which there is no hope of victory in war. And if music has been pressed into the service of religion in all ages, so has beauty. Those wondrous worshippers, of India, who, thinking that the perishable structures raised by human hands could not be fit dwellings for the immortal gods, made them temples by excavating into the everlasting hills, painted the rocky roofs and walls with colours which have lasted to this day. And many centuries later the sublimest spirit in Christendom freely consecrated his genius to the work of spreading before the worshippers in the house of God such visions of beauty as might lift them in spirit into the New Jerusalem, with its walls of jasper and its

gates of twelve pearls, every several gate of one pearl.

In the progress of the taste for beauty in colour there are, as might be expected, distinct stages. Even animals are attracted by bright and glittering things, especially birds, which are more æsthetic than beasts. Of this we need scarcely any other evidence than their own bright hues, for, though the theory of 'sexual selection' has been pushed to absurd lengths, we may safely say that the brilliant colours of the males of many birds are put on for the admiration of their own kind, and not for ours. Beasts are not thus beautiful, and have no eye for such beauty. But there is abundance of other proof that birds are charmed by bright colours. The Bower Birds of Australia build themselves bowers, or arbours, on the ground, to promenade in, and decorate them with shells and other pretty things. And many common birds, such as the crow and magpie, will carry off a silver spoon, or even a brightly coloured rag, and stick it about their nests, or hide it, as a treasure, in some secret place, where they go and look at it occasionally. The taste of the savage does not, perhaps, go much further than this. He will take any bright, or highly coloured, thing and stick it about his person to make himself look pretty; or he will hang it on

The first, simple delight in bright colours

the ear of his wife, or the tip of her nose, and admire her. And I am afraid a little of the same crude taste lingers about us still and sometimes peeps out in the jewelry that we wear. But let that pass, and may the ladies pardon me.

This delight in a bright colour is the first stage of the love of beauty, and there are degrees in the development of it. I believe that the variety of colours distinguished by an uncivilised man is very limited, in comparison with the differences recognised among a cultured people. In India a groom appears to have only three or four words by which he can describe the colour of a horse. All browns, bays and chestnuts are red, and all greys are white, except iron grey, which may be black. From this test of the words in common use it has been argued that the perception of colours among the ancient Greeks and Romans must have been dull in comparison with ours. This is borne out by the poverty of classical literature in descriptions of scenery. But in this respect we were no better two centuries ago. Those glowing descriptions of the beauties of nature which characterise modern books of travel are quite a recent thing. And landscape painting is quite a modern art. The emergence of this beautiful art, like Venus from the sea, and the rapid popularity which it has acquired,

Progress in discrimination

have had a widespread effect in educating the eyes of the European races to discern the beauty which lies scattered with lavish bounty on the face of the earth for rich and poor alike. And another, less dignified, cause is contributing. The invention of a multitude of new and brilliant dyes has given us such a series of object lessons in tints and shades of colour as no previous generation ever had. Then the need for precision in the description of these has called forth a vocabulary of new names. So a university for the study of colours has been established in every fashionable town, with milliners and dressmakers for professors, and ribbons for books, and every shop girl has graduated by the time she is fifteen. With a finer discrimination of colours comes an inevitable change in our preferences. Red is the hue which excites the eye most strongly, and yellow next, and these are the two favourites with the mass of mankind. Everyone who has lived in India knows how the *Malee* delights to make his garden glorious with flaring yellow marigolds, but he can see no beauty in the delicate mauve and white blossoms of the forest orchid. We infinitely prefer the latter, and say he has no taste, while he certainly thinks we have very little. Both are wrong. It is taste that makes him love those bright flowers, a taste of which the most highly bred dog is destitute; and

it is the same taste in another degree that causes us to reject them. Here is the moral of the curry-comb again, which I said in the beginning would help to light up many dark places on our way. That which pleasantly tickles the horse would torture us if we raked our backs with it. Yet we have the same nerves as the horse, and can be tickled too ; only it must be done gently, because our skins are thin. The Indian gardener's eyes are on the same level as his other senses : he relishes hot curry for the palate, the *chumpa* and screw-pine for the nose, and the *tomtom* for the ears. In all these matters we have grown more sensitive, so that while we delight in what he cannot detect at all, we cannot endure what he delights in.

From delight in single colours let us pass on to the enjoyment of colours in harmonious combination. Of this the average Indian *Malee* has scarcely the faintest conception. A bouquet of his contriving seems to an Englishman to be a deliberate outrage on the eye. In the centre he will put a great red 'shoeflower,' five inches in diameter ; round that a ring of red roses, and then a ring of orange marigolds. If the next ring is white, it was not put there for its colour, but for its odour, which will come upon you like a blow between the eyes. As a result of all the education to which I referred in the last paragraph,

Harmony of colours

we have grown exceedingly sensitive about harmony in colours, and the sight of two colours side by side which do not 'match' is almost as irritating as a discord in music. In these matters the ladies take the lead, of course, for the time and study which they devote to the subject gives them an easy pre-eminence. What a symphony in colours is a well-dressed lady of Europe at the present day! Others may admire the Parthenon at Athens, or Etruscan pottery, or the ware of Kioto, or what they will; but when I want to nourish my soul with the contemplation of what human genius and industry can bring forth, I take my stand in some street where the shops are richest, and watch the fashionable dames and damsels who gather like butterflies to a flower garden. Observe that ribbon of 'old gold,' so casually stuck on that left shoulder, like an autumn leaf fallen by chance. Ah! that is the *ars celare artem.* That is one of many ribbons which were laid in turn upon that dress stuff before it was a dress at all; and after each she stepped back three paces, and the dressmaker stepped back, and there was grave debate and interchange of wisdom; then senior counsel was sent for, and came in, and gave judgment in favour of the 'old gold.' And it was chosen. And all this has grown out of the savage woman who found a flamingo's

feather and stuck it in her matted hair and grinned as she strutted among her neighbours' wives!

What is the fact of it?

But what does it mean? When a lady says emphatically that this ribbon will not 'go' with that material, what is it that she perceives? The more I turn this question over in my mind the more clear it becomes to me that we are as yet entirely in the dark on the matter. Nothing that we know, nor any theory that we can provisionally accept, gives us even a promising clue to the meaning of those perceptions which we class as Harmony of Colour. The word harmony, which we instinctively use in this connection, suggests that music may furnish a key,

Musical theory of colour

and desperate efforts have been made to establish a musical theory of colours. The idea is very fascinating, but it breaks down in the working. As we have seen, a musical note is a sound produced by the uniform vibration of air, and all concord can be traced to simple ratios between the rates of vibration. If in one note the waves are 100 to a second, and in another 200, then the second note is the octave of the first; but 150 will give the 'major fifth' of the first note; and so on. Now we have seen that in light, too, each colour has its wave length, or rate of vibration; but since this rate in the extreme violet rays is just double what it is in the extreme

red, the whole colour scale gives us but one octave. The range of musical sounds is at least seven octaves. Again, the intervals between harmonious colours are not at all the same as those which divide harmonious sounds. The colours which make the most effective and pleasing contrasts are those pairs which we call complementary, such as red and green, yellow and blue; and these are the pairs of colours which, when blended, make pure white light. I refer, of course, to the pure colours of the spectrum; but compound colours also, every tint and shade, in short, has its own complementary. The complement of pink is a pale sea green, and the complement of reddish brown is olive, and these pairs match. Now, there is nothing in the concord of sounds which corresponds to this relationship or helps to explain it. Lastly, two colours, when blended, make a third, in which we cannot distinguish the component parts, while the ear distinguishes two notes that are sounded together, whether they accord or not. I think too much has perhaps been made of this last difference. Such terms as 'bluish green' and 'purplish red' seem to show that we do in some cases distinguish the elements of a compound colour, and, on the other hand, when two notes accord perfectly (octaves, for instance,) an unpractised ear may not notice that more than one note is being sounded. Still it must

be admitted that the eye does not analyse colour as the ear does sound. Not only so, but it cannot even judge one colour correctly in the presence of another. In the presence of bright red, grey looks green 'by contrast,' as we say; but in the presence of strong yellow, the same grey will look distinctly bluish. If we stare for a while at any bright colour, everything we look at for some seconds after is tinged with the complementary hue. If the ear were liable to be biassed in this way musical science would have to be recast.

Notwithstanding all this, however, there is certainly an analogy between the pleasure-giving influences of colour and musical sound. But we must beware of confusing the subject by comparing music with painting. Between these two arts there is no connection whatever. Their purposes are different. The painter aims to represent objects that we have never seen, so that we may know what they are like; or objects that we have seen, so that we may see them again when they are not present with us. It may be the face of a friend, it may be a house we once lived in, it may be a battle scene which we never saw, but which the picture helps us to realise. If a barrel organ could be invented which would give us the varied sounds of a farmyard—the lowing of cows, the distant singing of larks, the near

Music and painting

cackling of fowls, the conversation of yokels, the song of a melodious milkmaid, the heavy tread of clodhopping boots, the creaking of a barn door—all faithfully produced and skilfully arranged to follow or mingle with each other, so that the dreary city man, sitting with his eyes closed, would be carried back to the scenes of his boyhood, and live again for an hour in that happy time

> . . . when meadow, grove and stream,
> The earth and every common sight,
> To him did seem
> Apparelled in celestial light,
> The glory and the freshness of a dream,

then, indeed, we should have an art of sound closely corresponding to the art of painting. But it would not be music. Music does not aim to represent anything in nature—but to create something which is not in nature, a march of sweet sounds, so ordered in their relation to one another that they work together to touch some secret spring in our nature and awaken strange thrills of delight. Colours may be arranged for the same effect, and, in fact, this is done in all decorative art. The simplest wall-paper is a tune in colours, standing at about the same level, I estimate, as a melody on the Jew's-harp. Stained-glass windows are a higher effort. The most effective form of 'colour music' that we have as

Colour music

yet is in fireworks, and Mr. Haweis has written very enthusiastically, in 'Music and Morals,' of the possibilities of this art. 'What a majestic symphony,' he says, 'might not be played with such orchestral blazes of incomparable hues! What delicate melodies composed of single floating lights, changing and melting from one slow intensity to another through the dark, until some tender dawn of opal from below might perchance receive the last fluttering pulse of ruby flame and prepare the eye for some new passage of exquisite beauty.' This is very ravishing; but where is the genius who shall conceive and present to us these oratorios of beauty? He may be among us now, but he has no means of utterance. If there had been no organ when Handel lived, no violin, no harpsichord, the 'Messiah' would never have been given to the world. And the colour genius has no instrument. Fireworks may serve for grand orchestral effects, when the time comes; but they are altogether too unmanageable for the composer and the private performer. We require an instrument by which a man, playing to himself, may control his colours as a pianist controls his tones. And, looking to the marvellous applications of science, especially electric science, within the last generation, who shall say that such an instrument is not in the near future? When it comes, then 'colour music'

will be an art and a science, and we can no more foresee its possibilities now than an African, listening to his 'piano' of fifteen tuned calabashes, the music of which, Livingstone says, is 'not unpleasing,' can imagine the creations of Wagner.

The pleasure-giving influences at the disposal of a colour musician run strikingly parallel to those which combine to make up the charms of music. Let us compare a pattern in a succession of single colours with a simple melody. I divided music into three elements, namely, *time*, *tone*, and *tune*. For *time* in this case we have *form*, because the eye measures space, but is indifferent to time; whereas the ear notes time, but is insensible to the laws of space. The ear is charmed by motion according to law through the rhythmic sounds to which it gives rise, and the eye reads the same charm in the perfect figures which it executes. Nor is there any limit to the variety and beauty of the figures which may be presented to the eye by as simple an instrument as a kaleidoscope. The second element of music is *tone*, which corresponds to colour, or hue. It is, in fact, exactly the same thing, from the natural philosopher's point of view, and it has three distinct qualities analogous to those of tone. Let us look at this. One tone may differ from another in its *pitch*, its *loudness*, and its *quality*. The pitch depends, as we have

already seen, upon the rate of vibration, and this is exactly the difference between colour and colour. What we call 'warm' colours are just the deep tones of light, and 'cool' colours are the high tones. Again, a tone may vary in loudness, and so may a colour in luminosity. Any colour may be made to pass from *forte* to *piano* by softening the light. Lastly, one tone may differ from another in its quality, or *timbre*—that character by which we can tell a note on a flute from the same note on a violin, and can even distinguish one violin from another by the purity of its tones. To this we may fairly compare the purity, fulness, or 'saturation' of a colour. And it seems to me that there is little difference in the pleasure which the eye derives from a pure tint, and the ear from a pure tone. The third element of music is *tune*, or the pleasing relation of different notes to one another, and there is a similar relation of colours. So colour may follow colour in succession, as sweet as the notes of 'Home, Sweet Home'; each colour in itself so pure and radiant that the eye will love to dwell on it, and all expressed in forms of fairy grace. This were melody indeed.

But there is harmony in music, the mystic effect of concordant notes sounded together; and this also may have its analogue in colour music. For our pattern may be illuminated, not with

one colour, but with many, harmoniously disposed; and as one combination gives place to another, each section will pass into some new tint, doubly beautiful in its relation to the one which preceded it and to all that surround it. And, as in every good painting there is one predominant hue which gives its character to the whole composition, so each combination in our colour symphony may be characterised by a leading colour. The succession of these will constitute the air, and the subsidiary colours the harmonies.

Whether colour music can ever come to exercise the same magic power over our emotions which the music of sound possesses, we cannot know until we have felt it; but it is not difficult to believe that it may. And the two may work together. What a concert that will be! The crashing thunder of all the instruments, and the lurid flashing of fiery lights stops in sudden silence and darkness! A still, small voice, lighted by a dawn of softest colour, awakens the theme again. It swells simultaneously in loudness and brightness; it passes into ripples of joyous sound and flowing rainbows, which make the blood dance in all our veins. Now, as we sit in a crowded concert hall, we often close our eyes at the sweetest passages, that the heavenly tale which our ears seem to be telling may not be contradicted by the

too earthly sights before us. Then we shall open our eyes, and they will enforce the tale of our ears, till our 'high raised fantasy' may exclaim with the rapt apostle, 'Whether in the body, I cannot tell; or whether out of the body, I cannot tell.'

When the science of colour music shall be studied as the science of harmonious sound has been, then, perhaps, we shall discover the secret of beauty. And of this I feel certain, that, when that day arrives, it will but present us with another illustration of that wonderful truth which has passed before us more than once already. We have seen that every element of music proves, when analysed, to consist in the simple relations of numbers, and may be expressed in the language of arithmetic; we have seen that every graceful form may be brought under the rules of geometry; so I am persuaded that whatsoever we find to be lovely and delightful in colour will prove to be an expression, in some form, of the eternal laws of time and space.

CHAPTER XII

THE BEAUTY OF THIS WORLD

ONE question has often puzzled me in past times, as I have thought over these things and looked out upon earth and sky. It is this. Why is there so much beauty in creation? How is it to be accounted for? And now the answer has become very plain to me—because beauty means *law*, and all creation is under law. When the rivers cut their winding way to the sea, the waters are running according to law; when the winds blow, their course is guided by law; when the clouds form, their forms are shaped by law. I cannot resist the temptation to quote here a passage from the works of one who bears a name second to none in science, and has also the eye of an artist. He has been speaking of music. 'Finally,' he says, 'I would direct your attention to an instructive spectacle which I have never been able to view without a certain degree of physico-scientific delight, because it displays to the bodily eye, on

All-pervading law

the surface of water, what otherwise could only be recognised by the mind's eye of the mathematical thinker in a mass of air traversed in all directions by waves of sound. I allude to the composition of many different systems of waves as they pass over one another, each undisturbedly pursuing its own path. We can watch it from the parapet of any bridge spanning a river, but it is most complete and sublime when viewed from a cliff beside the sea. It is then rare not to see innumerable systems of waves of various lengths, propagated in various directions. The longest come from the deep sea and dash against the shore. Where the boiling breakers burst shorter waves arise and run back again towards the sea. Perhaps a bird of prey darting after a fish gives rise to a system of circular waves, which, rocking over the undulating surface, are propagated with the same regularity as on the mirror of an inland lake. And thus, from the distant horizon, where white lines of foam on the steel blue surface betray the coming trains of wave, down to the sand beneath our feet, where the impression of their arcs remains, there is unfolded before our eyes a sublime image of immeasurable power and unceasing variety, which, as the eye at once recognises its pervading order and law, enchains and exalts without confusing the mind.'

That which delighted the eye of Helmholtz

in this scene, the sublime spectacle of immeasurable power and variety pervaded everywhere by law and order, may be seen wherever we choose to look for it. We admire the harmonious grandeur of an ancient forest, and stoop to look at the humble, but perfect, grace of a fern leaf, and it scarcely occurs to us that plants and trees do not grow up anyhow. But read the following passage, taken almost at random from an ordinary handbook of botany:

'It is found that the modes of arrangement of leaves are in accordance with certain general laws; and a particular study of these laws has been pursued under the name of Phyllotaxis. Leaves exhibit two principal types of arrangement: either they are solitary, one only occurring at a node, or two or more spring from the stem at the same level. . . . Alternate leaves exhibit many modifications of arrangement. Sometimes they are truly alternate; that is, the second leaf is exactly on the opposite side of the stem from the first; a series of leaves arranged in this way forms two perpendicular rows. Such leaves are termed distichous, or two-ranked. If the second leaf is not opposite to the first, but at a point distant from it one-third of the circumference of the stem, and the third leaf one-third further round, the fourth leaf, likewise distant one-third from the

Laws of growth

preceding, will stand over the first. Leaves so arranged form three perpendicular rows, constituting the tristichous, or three-ranked arrangement. Now when a line is drawn round the stem so as to pass regularly from leaf to leaf, we find that its course is spiral. In the distichous case the spiral line, starting from any given leaf, completes one circuit, and then commences a new one at the third leaf. In the tristichous arrangement the spiral completes one circuit and begins a new one with the fourth leaf. The series of leaves included by the spiral line in passing from the first leaf to that which stands directly above it is called a *cycle*; the fraction of the circumference of the stem which measures the angular distance between any two succeeding leaves in a cycle when projected on a plane is termed the *angular divergence.* In the distichous, represented by the fraction $\frac{1}{2}$, it is one-half of 360°, or 180°; in the tristichous, or $\frac{1}{3}$, it is 120°. These fractions not only represent the angular divergence, but also the entire character of the arrangement; for the numerator, as is seen indicates the number of the spiral forming a cycle, while the denominator expresses the number of leaves in a cycle.' Further on the writer says: 'When we place the foregoing figures together, thus: $\frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{3}{8}$, it will be observed that each fraction has its numerator composed of the sum of the

numerators of the two preceding fractions, and its denominator of the sum of the two preceding denominators; and it is really found that all higher complications in normal conditions of stems exhibit some further indication of the same ratio.'

But surely I need quote no more. Let us turn to shells. I will not say anything in praise of the beauty of shells. The child and the savage are at one with the artist on that subject. Then read the following note from a handbook of conchology: 'The curve of the spiral shells and their opercula, and also of the nautilus, is a logarithmic spiral, so that to each particular species may be annexed a number indicating the ratio of the geometrical progression of the dimensions of its whorls.'

If you ask, 'Why should such humble growths exhibit such precise geometrical forms? What is the object of it, or what is the meaning of it?' I answer, 'Why is the orbit of the earth an ellipse, and the path of a comet a parabola?' The earth spins round the sun at the rate of nineteen miles in a second, and the snail grows round its own axis at the rate of an inch in a year; but both are moving under law, and therefore must work out true geometrical forms. A healthy and well-fed snail grows like money placed at compound interest, its rate of increase advancing from day to day in geometrical progression. One side grows faster

than the other, because its vital organs on one side are aborted, therefore it turns upon itself and forms a spiral; but both sides advance under the same rule. Thus two sums of money may be placed at compound interest at different rates, and they will increase according to the same rule, but not equally fast. The banker can express this in figures; Nature expresses it in forms, and it is given to us to delight (here is the mystery) in such forms, and call them beautiful. In these days, when so much childish nonsense is written about the evolution of beauty by sexual selection, it is good to remember that most shells are covered during life with a thick brown skin, or bury themselves habitually in mud, or walk at depths where there is no light to see them by. No mortal eye ever looked on the thing you so admire until it was dead and empty, and the waves had scoured it with the sand of the shore. It is only a record of the obscure life of a snail that God made.

What I have said is not contradicted by the fact that some creatures are less beautiful than others, and some are not beautiful at all. This world, as at present constituted, is a scene of conflict in which everything must struggle for its place, and hold it as best it can, or perish. It furnishes many examples of success and many of partial failure, and the bowels of the earth are

Imperfection

full of the memorials of those that have failed altogether. Some creatures have to pass their lives under such conditions that they dare not be beautiful, others that they cannot. Some shells are forced to live in crevices of rocks to avoid their enemies, and their growth is distorted by their situation into curious and ungraceful shapes. The poor mole, which must hide itself under the earth or be killed and eaten, cannot have the grace of the wild ass used to the wilderness that 'snuffeth up the wind.' The simple grace of the fern, that grows in a sheltered nook and rises and perishes in a single season, is not possible to the oak that must weather the storms of a hundred winters. Even among the ferns not one frond in a score attains to perfection; some are turned aside by obstructions, some are deformed by their own efforts to press into the unequal light, and some are eaten by snails. And so, while fragments of grace and loveliness are scattered lavishly on all sides, there is everywhere also imperfection and failure, and nowhere complete harmonious beauty. The art of gardening, and especially landscape gardening, is a testimony to the general consciousness of this. When dealing with music we observed that there is little or no music in nature, and that in man's ear he has an endowment beyond the conditions of his present life. This is equally true

of the eye for beauty. Deplorably as man may fail to appreciate even the fragmentary beauty scattered around him, there is in him all the while a faculty designed to discern and delight in higher things than any that nature can offer him.

The colouring of the world

So much for the grace of the forms with which the world is furnished; but why are the colours so lovely in which it is arrayed? Here we pass from comparative light into utter darkness. As Mr. Beddard says, in his instructive book on 'Animal Coloration': 'At every step in animal coloration we are met with closed doors, which can only be unlocked by keys furnished by an intimate chemical and physiological knowledge such as we do not at present possess.' Aye, and when the doors are unlocked shall we know what we are looking for? As yet we have not found out what the fact is which we recognise and enjoy as harmony of colour. Some things, however, we can see plainly enough. Much of the beauty of plants and animals lies in the arrangement of their colours, and this, of course, must be guided largely by the lines of growth. As the shell advances in its logarithmic spiral, colouring matter secreted in any part of it will take the same course and form spiral lines. If the secretion is intermittent it will form spots in spiral rows. The colours of butterflies are very commonly

arranged in patterns based upon the veining of the wings. The same is true of the petals of flowers. Even among the higher animals a connection can often be traced between the colours and the form. Brown or tawny animals have generally a line of deeper shade along the spine. From this the intensity of the colour decreases gradually until it becomes white or very pale on the under parts. Even as regards the bands or spots of tigers and other animals, it has been asserted that a connection can be traced with the arrangement of the nervous system. Again, there are many tendencies in the arrangement of colours which are so general that there must be some common cause for them. The tip of the tail in beasts is more often black than otherwise. The tails of many genera of birds are always banded, and the last band is the broadest. The lower part of the back in birds, where the wings cross and cover it, is very often white, but sometimes brilliantly coloured. A conspicuous white mark across the wing is a common mark in birds quite unrelated to each other. But this is an endless subject. I have only given a few examples, to show that the patterns of colours in the animal and vegetable kingdom are, to a great extent, governed by the same laws which work out such beautiful forms.

But through and beyond all this there is a

harmony in the colours themselves of living things which is still an enigma to me. Look at the harrowing combinations which a man devoid of taste will perpetrate when he tries to arrange a glass of flowers, or a woman devoid of taste when she dresses herself. Is there anywhere a bird, or a butterfly, or a flower, so dressed? No. There is a depth of significance in those too familiar words, 'Verily I say unto you that even Solomon in all his glory was not arrayed like one of these.' There appears to be some harmonious relation between even the foliage and the flower. No leaves match a flower so well as its own. Often the shape of a flower vase, or some other circumstance, demands a different kind of leaf, but how difficult it is to find one that will do. I confess that I lean strongly to a notion that the colours of living things are to a large extent wrought out directly by the light that falls upon them. That light has a direct influence on the production of colour is not a notion but a fact. Its effect on the green of leaves has already been referred to, and other examples may be found in every direction. Fishes generally are dark on the back, but white or silvery on the belly; but the sole and the flounder are brown on one side and white on the other, because they lie habitually on one side, and that gets bleached. The colour-

Is light itself the painter?

ing matter which makes one half of the skin brown is not produced in the other half for want of light; or, rather, it fades away for want of exposure to light, for these fishes are coloured equally on both sides when they are very young. But if they are kept in a tank with a mirror at the bottom they retain a good deal of colour on the under side. The experiment has actually been made. A much more curious example of the effect of light is seen in many tropical butterflies, which, in the chrysalis state, are differently coloured according to their situation: if attached to a leaf they are green; if attached to a trunk they are brown. The caterpillar is red, it may be, or black, but it hangs itself in some safe place and casts its red or black skin, and comes out a soft, inert, colourless lump of jelly, the raw material of the coming butterfly. In a few seconds its surface becomes green or brown, according to the colour of the light reflected on it from the objects nearest to it, and it sets hard in that colour, so that it cannot change afterwards. The natural selectionist steps in here and says, 'Ah, but this power of adapting itself to its environment has clearly been developed in the pupæ of these butterflies by natural selection.' Well, I have no objection. But what is it that has been developed? Not greenness, nor brownness, but something which

will become green or brown according to the colour of the light that falls upon it. And if there is such a something available for the chrysalis, there is also for the sole and the flounder, that they may take their colour from the sand on which they lie. Along this path we may find a simple explanation of many of those 'protective resemblances' which excite the admiration of the naturalist. But in other cases light acts in quite a different way upon colour, the material, perhaps, being different. The glorious scarlet ibis, when taken from its native sun and placed in the Zoological Society's gardens, soon becomes pale and dull. I have noticed that captivity, even in its own country, produces exactly the same change in the crimson feathers of that brilliant little bird, so commonly kept as a cage bird in India, the Amadavat (*Estrelda amandava*). In these cases, and a hundred others which might be cited, light is manifestly the worker; but the effect of its working varies according to the material which each living organism is able to present to it; and that depends upon an endless chain of conditions, some of which we can see or guess, and many of which we cannot. And if light is motion, and beauty is the music of that motion, and if colour is nothing else than such a disposition of the atoms of matter as fits them to dance to one or another of the tunes that light plays, then

is it difficult to believe that, wherever light operates to direct those dispositions, there will be a harmonious relation in the result? A violin improves with age and use; constant vibration to harmonious measures for a hundred years, though it is but dead wood, modifies its very structure so that it responds ever more and more harmoniously. And may not the waves of light, that play upon the tender growing tissues of living things, work in them that which will respond harmoniously to its own action? But we must draw rein. It is easy to get rhapsodical on a subject of this kind. There is something so fascinating in the conception of this unseen influence from heaven working in all things whose faces are turned towards it, and imparting to each the power to receive it and reflect it, in ways various as their own natures, but always beautiful, that if we allow a traitorous imagination to play with it, we may soon find ourselves hugging it as hidden wisdom. And perhaps it is only a foolish fancy. Let it pass.

CHAPTER XIII

OTHER SENSES

ARE there any others? We are very apt to think of our five senses as if they were necessary properties of intelligence, and to suppose, as a matter of course, that all sentient beings feel, taste, smell, hear, and see as we do. If anatomical examination shows that any creature is devoid of ears or eyes, then we think of it as we do of a deaf or blind man, compassionately. And with this way of thinking, perhaps, we sometimes combine an assumption that there is no need for any other sense, since the five we have suffice to make us acquainted with whatever can be known of the material world. A little reflection on the facts that have already passed before us ought to dispossess us of both these conceited notions. For what is a sense, strictly speaking? Only a high degree of sensitiveness in some part of our bodies to some particular kind of motion, or action, in the multiform matter with which we

are surrounded. We are specially sensitive in this way—(1) to the contact of any solid thing, but not of air; (2) to the chemical action of some substances when dissolved in the moisture of the mouth; (3) to the similar action of minute particles floating in the air; (4) to the agitation of the air itself, and (5) to the agitation of the invisible ether. But are there no other movements going on around us? What of electricity? A well known and most excellent text-book of physics defines it as 'a powerful, physical agent, which manifests itself mainly by attractions and repulsions, but also by luminous and heating effects, by violent commotions, by chemical decompositions, and many other phenomena.' Very like a description of a ghost in a haunted house, is it not? Well, this 'agent' has been behaving in these ways ever since man was in the world, and the consequences of its more violent outbreaks have often been patent to one or other of his senses, or to several at once. His eye has been almost blinded with light, his ear deafened with noise, his sense of touch shocked with a brick from a shattered wall, and his nose assailed with a sulphurous odour. But the 'agent,' itself has remained unseen and unknown. It is scarcely three hundred years since we first began to suspect its existence. By patiently tracking its

Electricity

footsteps, however, we have discovered a great deal about its habits and ways of working, and we have brought it into subjection, so that it has become a very Ariel in our service, as potent, as active, as obedient as that 'fine spirit,' and as invisible. It is curious to reflect on what the consequences might be if we were endowed with an 'electric sense.' It would probably add a new quality to matter, as distinctive as colour, for one substance differs as widely from another in its reaction to electricity as to light. Only lay a thin copper wire for its path, and the electric sprite will put a girdle round the earth in much less than forty minutes; but an inch of glass or indiarubber will bar its way absolutely.

Then there is magnetism, a 'property' of a certain kind of iron ore, by virtue of which a slip of it, delicately balanced, will point to the north and south. But this property is transferable, or reproductive, for it is imparted to any bit of common iron that comes within the influence of a magnet, and forthwith that bit of iron becomes a magnet, wanting to point to the poles and to hug to itself all other iron. Now, if it is ever allowable to assume anything, surely we may assume that an influence which urges every magnet to point to the poles of the earth must proceed from the earth, and

Magnetism

since no magnet is ever free from it, by day or night, wherever it may be placed—on either side of me, under me, or over my head—it seems to follow that I pass my life steeped in that influence. But I am not conscious of it, because there is nothing in me which responds to it. If there were, perhaps I should have a 'sense of direction,' such as pigeons and bees and some other animals have been supposed to be endowed with.

The X rays

Lastly, what are these Röntgen rays, which have suddenly revealed themselves to us during this last year, passing clean through our bodies and photographing our bones? The open eye may be held right in their path, close to their very source, without detecting anything. Doubtless they have passed through the eye and the brain and the skull, and are speeding on their way through space, but they have left no sensation behind them. What are they? Are they in the air about us, always, or at special times? They seem to proceed from a certain point in the arc of light which we can produce by sending a strong current of electricity through a vacuum; but they are not that light. Are they generated when lightning flashes through the sky? Then, if we had a sense responsive to them, we might see through each other in a very literal sense during a thunderstorm! The discovery, so late in

the day, of this marvellous agency ought to make us humble. How many other movements may there be around us, to be discovered as we proceed, or never to be discovered at all? We can never say a thing is not because we do not know it. At this moment, as I write, there may be round about me percipient beings, observing not only what I do, but what I think. I do not mean spirits, but corporeal beings, with individual bodies as material as our own. If you start at this suggestion, read what Professor Tyndall deliberately writes about that ether, the very existence of which is a mere hypothesis started to account for the phenomena of light: 'This is why the foremost men of the age accept the ether, not as a vague dream, but as a real entity. Ask yourself how the vast amount of mechanical energy actually transmitted in the form of heat reaches the earth from the sun. Matter must be its vehicle, and the matter is according to theory the luminiferous ether.' If Professor Tyndall was not afraid to say that this ether, which we can neither feel, nor see, nor weigh, nor subject to any process of scientific investigation, must be matter, on what possible ground can you or I reject the idea of material, but imperceptible, bodies? Remember, please, that I do not assert, or suggest,

'More things in heaven and earth'

that there are such—I leave that to the Theosophists—but I say that to deny such things is at least as irrational as to assert them.

To return to our subject, if the world is astir with so many influences, known or unknown to us, it is surely foolish to suppose that the perceptions of any other animal are bounded by precisely the same limits as our own, especially when we find that in other respects they are constructed upon a totally different plan. We have seen already that ants appear to be very sensitive to the ultra-violet rays of light, which are quite invisible to us, and they and other insects may have organs for perceiving electric, magnetic, and other conditions to which we are not susceptible In that case an aspect of the world is manifest to them of which we, in the very nature of things, can form no conception. And even, with respect to the senses which we have, we ought to bear in mind always that what we perceive is not the measure of what is. You stand on the seashore as the moon rises out of the water in the east, and a shimmering track of silver glory stretches from it to you. At such a time did it ever occur to you that the whole surface of the sea is blazing with the same effulgence? That streak which you see is your portion of it, and every eye that looks on has its portion, and none can take another's.

CHAPTER XIV

RETROSPECT

In the beginning of these meditations I likened myself to a mountain climber who has found a point commanding a view which seems to him so beautiful and sublime that he cannot rest until he has persuaded his friend to accompany him to the same point and share in his delight. I do not forget that the result may be bitterly disappointing. The friend may find the journey very toilsome, and when he reaches the end he may see nothing in the view to justify his guide's enthusiasm. And he may be candid enough to say so. I can only hope that it will not be so in this case. I trust that the way has not been over tedious, and I think that our toil has been lightened by not a few pleasing prospects by the way. At any rate, we have reached the top at last, and it only remains to rest awhile and cast our eyes once more over the whole prospect before we return to the dusty plains of life.

The salient feature of this aspect of the world is Mind linked with a material Body, and gradually, by means of that body, taking into its consciousness the world of matter in which it finds itself. At first the body given to it seems to be so simple, so formless, without parts or plan, that we can scarcely think of it as a distinct individual organism, but rather as a small quantity of organism, a portion of living matter. Nevertheless, we find that the whole substance of it is endowed with discernment of the distinction between itself and that which is not itself. And in matter which is not itself it is able to perceive quite definitely a fitness for the supply of its own requirements, productive of inward satisfaction, or an unfitness, productive of dissatisfaction; for it chooses and refuses. So it tastes the mystery of pleasure and pain. We have seen this first simple consciousness of the contact of something, which is not I, expand into a perception of various properties of matter—hardness, softness, weight, etc.; of heat, of rest and motion, and finally of forms and the properties of space. Alongside of this, that other discernment, of those qualities of substances which make them suitable for the nourishment of the body, has expanded into an infinite variety of pleasure-giving perceptions, garlanding with de-

Mind perceiving matter

And the properties of matter

lights the whole business of taking food, which is and always must be, the principal occupation of the great majority of living creatures. At this point we first notice, what becomes clearer and clearer as we proceed, that the perception of good comes, not by way of argument, but as a joy, and the perception of evil as a pain. It is true that the good which the sense of taste discerns is not absolute, but relative, good ; each nature finds satisfaction in that which is good for it. But this is the beginning of greater things.

With pleasure or pain

And now see how, by an easy transition, the perception of solid things in contact with the body, or taken into the mouth, passes into examination of those minute particles of their substance which are carried about by the currents of the circumambient air. So every breath taken into the body brings tidings from afar. Nor are these perceptions unaccompanied by approval and disapproval ; and if at first its alliance with the palate guides the nose in its judgments, so that those things smell sweet which are good for food, and those give offence which are poisonous or unwholesome, it soon rises above this, and finds unexplained delight in fragrances which carry no promise of any grosser satisfaction. On the other hand, it finds offence in the emanations of decay and corruption, and so becomes the chief

Extending its investigations

instigator of the mind in that revolt against uncleanness which is always associated in some mysterious way with the elevation of the whole nature.

Concurrently with the development of these perceptions we see, as we go up the scale of animal life, an advancing sensitiveness to the tremors of those two elements (I do not use the words scientifically) in which every living thing is steeped, because no life can exist without them—namely, the atmosphere, which envelops this world to a height of fifty miles, and the invisible ether in which not only this world, but all the worlds swim. Nothing can move without stirring the one, and no solid thing at least can either rest or move without reflecting some of the other, and by these tokens sure intelligence may be gathered. So we find this first dull and diffused sensitiveness localised and refined in proportion to the capacity and need of the mind, at each stage in the unfolding of the great plan, until it becomes two instruments of such complexity and delicacy that the one can compare and recognise again the difference in the kind of tremor which is imparted to the air by the rustling of a silk dress and a sheet of paper, while the other can distinguish the manner in which the light is reflected by the surfaces of those two substances, though both may

Acquiring better instruments

have precisely the same colour. And it is well worth while at this point to consider again the remarkable difference in the fields of knowledge which are opened to the mind by these two instruments. The eye reveals to its possessor at once his situation in this world. There is the ground on which he stands; the sense of touch in his feet has already made him acquainted with that; but now he sees that it extends on all sides, inviting him to go which way he will; that it is clothed with verdant grass, or waving corn, adorned with trees and spangled with flowers; that in the fields are cattle, in the trees birds of varied plumage; among the flowers bees and butterflies, all busy and happy with their own concerns. The sizes, forms, colours and situations of all these things are registered in his mind by one act of sight. Then, above him there is the sun, making the difference between night and day; also the lamp of the moon and ten thousand lesser lights. All these things are shut out, absolutely and for ever, from the mind that is not lighted by an eye. We cannot measure the difference between a bird or a butterfly, which knows the world in which it moves, and a worm or a mole, which knows nothing except what it can feel; for there is no measure of it. What a contrast the ear presents! It knows nothing of things that are, only of things that

The scope of the eye

move; and their sizes, forms and colours are not revealed to it, but only their motions, whether they are approaching or departing or passing by, slowly or swiftly, gently or roughly. The eye can see all this, and at first it would seem as if the sense of hearing served for little else than to duplicate a portion of the perceptions that come by the sense of sight. But in a wonderful way a path has been opened for the ear into regions where the eye cannot follow it at all. For sounds are so easily made and controlled that there is no other agency so convenient whereby mind may signal to mind what is going on within it. So language is born, and while the eye reveals to each mind the material world in which, by virtue of its material body, it has a standing-place, the ear lifts the curtain on that inner world of thought and feeling to which itself belongs. Nor need we confine our views narrowly to man. Whenever you hear a cricket chirping, or a frog croaking, or bees buzzing in the hive, allow yourself to think that these humble creatures too have a share in the interest and joy of social life.

The scope of the ear

Primarily we find that these two senses are concerned, like the others, with matters pertaining to the needs of the body, but, ranging as they do over earth and sky, they bring in intelligence of many other things too, by which the expanding

mind is stimulated and fed. And they bring something else, something quite distinct from intelligence for the mind ; for at times, both by the ear and the eye, there comes an approving perception of some hidden good, fraught with a joy which strangely entrances the whole being, body and soul. It may be akin in its nature to those pleasures of which we have experience through the senses of taste and smell, but it differs from them in this, that there is neither relation nor association between it and the satisfaction of any bodily want ; and just for this reason it is declared by the universal consciousness of mankind to be a higher and nobler thing. This perception of music in sound, and beauty in colour and form, is beyond all question the sublimest exercise of the senses, when, independently alike of reason and experience, they pronounce a verdict of right or wrong from which there is no appeal to any other faculty. And it seems to me that no result of modern scientific discovery deserves to be ranked as more wonderful than the light which it has thrown on the facts that underlie these perceptions. For, as we have seen, the whole secret of harmony in sounds has been found to lie in numerical relations between the rates at which the air vibrates in producing them ; and, as far as our knowledge has penetrated, all beauty, in form at least, consists in the geometrical

A sublime perception

relations of lines and surfaces. So that we may say that every time the soul of man has been entranced by music, or charmed by beauty, he has been rejoicing unawares in those relations of time and space by which the whole universe is conditioned, those foundation lines which were laid on that day when 'the morning stars sang together and all the sons of God shouted for joy.' He has been echoing that shout without knowing why.

The faculty is innate

And now I should like to direct your attention very particularly to two or three facts in connection with the perception of beauty, which deserve to be well considered, for they are radiant truths, fitted to dispel much murkiness from our way of thinking about these and also about some higher things. First, observe that the faculty is innate, like the ear for music. Doubtless, as there are some men who are destitute of an ear, so there are some without the eye for symmetry, who cannot see a straight line, and there are others who are colour blind; but the perception of the beautiful in form and colour is part of the equipment of every normally constituted human being. There is a vast difference, however, between man and man in the degree of their endowment. Whole races indeed are distinguished by a special aptitude for æsthetic arts, or by a marked want of it. The Greeks led the world

once in these matters, and their old masterpieces are our models to this day. At the present time the Japanese surpass all the nations of Europe in their subtle perception of the charm of rightly proportioned irregularity.

It may be improved or deteriorated

In the next place it is to be observed that, be the natural faculty great or small, it is susceptible of much improvement by cultivation, and indeed without such cultivation it is little better than latent. And there is only one way of cultivating it, which is by the right exercise of it, and the right exercise of it consists in the contemplation of the beautiful. Every time that a man lets his eye dwell lovingly on anything because it is perfectly proportioned, or harmoniously coloured, his perceptions become more true, and his sensibilities more tender. And do not omit to notice that this has its counterpart; every time a man allows his eye to dwell on anything which is disproportioned, or discordantly coloured, or even to suffer any such thing without protest, his perceptions and sensibilities are dulled. So the eye may be debased until it even learns to love that which is unlovely, and to take pleasure in that which ought to give it pain. This holds equally true, as we have already seen, of the ear for music, and it is indeed true of every perceiving faculty. There is deep wisdom, then, in that well-known

saying of Goethe: 'Men are so inclined to content themselves with what is commonest; the spirit and the senses so easily grow dead to the impressions of the beautiful and the perfect; that everyone should study, by all methods, to nourish in his mind the faculty of feeling these things. For no man can bear to be entirely deprived of such enjoyments; it is only because they are not used to taste of what is excellent that the generality of mankind take delight in silly and insipid things, provided they be new. For this reason one ought, every day at least, to hear a little song, read a good poem, see a fine picture, and, if it were possible, speak a few reasonable words.'

It is an alarming thought that the joy which has been divinely linked with the perception of what is true and good and beautiful, in order that we might always be led upward, may be disjoined by our own action, and ally itself with what is false and bad and ugly, leading us downward. When this has befallen a man, what remedy is there? 'If the light that is in thee be darkness, how great is that darkness.' Bearing this in mind, let us beware of the pestilent fallacy which often lurks under those common sayings, 'Tastes differ'; 'Every man to his taste,' and such like. Let us see that taste can differ only in being right and wrong. A thing is not lovely because I love it, but because it is in

conformity with the lines on which this universal frame has been planned. If I cannot see its loveliness and love it, the loss is mine. For him who can see, however dimly, the paramount thing is to delight himself in that which is lovely, and the power to see it and rejoice in it will grow within him.

Higher perceptions still

Perhaps the reader has already begun to feel that we are drifting into a tone suitable to graver matters than the sight of the eyes and the hearing of the ears. And in truth, when we reach this point, we get very near to the gravest matters that can occupy the mind of man. The narrow chasm that separates them, if there is a chasm at all, is already bridged for us by the very terms which we have been forced to use. Our subject is the Five Gates by which the outer world has entrance into the city of Mansoul, but every time we use such words as taste, feeling, sense (and we can scarcely take many steps without using words of this kind), we are reminded that we have a host of perceptions which certainly never came in by any of those ways. The eye can see a green tree, but it cannot see *greenness*. That is an idea, something within us, which we have abstracted or distilled from a thousand sensations produced by green things. But the 'inward eye' can look at it just as plainly as the

outward eye can look at a green tree. If you ask, 'What is this inward eye, and how does it perceive?' I reply, 'What is the outward eye, and how does it perceive?' We may well leave the greater mystery till we have solved the lesser. For my part I can find no essential difference between the inward and the outward perceptions. The eye shows us a fellowman performing some simple act, the ear brings us a few words that he uttered—mere words, pulsations of the air—and the inward eye perceives *kindness*. By a further abstraction from a series of such little acts and words we discern the man's *character*. So we live in that immaterial, spiritual world, which is just as real and existent as the material, perceiving, distinguishing and recognising the souls of men, with their emotions, passions and conduct, just as we perceive the trees with their various leaves and fruits. And as the infant, in learning the use of its eyes, is wonderfully helped by its own hands, so our inward eye is helped in its judgments of outward things by the consciousness of what goes on in our own souls. And, as I have said, the words made for the one set of perceptions fit the other, for they are as like as twin brothers; and, indeed, they are of one family. Speaking of that exercise of the mental perceptions which we call 'common sense' from a physiologist's point of view, Dr.

The inward eye

Carpenter remarks, 'The parallel between the cerebral action which furnishes the mechanism of thought now under consideration, and the action of the sensorimotor apparatus which furnishes the mechanism of sense and motion, is extremely close.'

Common sense

Dr. Carpenter defines 'common sense,' in the popular usage of the term, as 'an attribute which judges of things whose self-evidence is not equally apparent to every individual, but presents itself to different individuals in very different degrees, according in part to the different constitution of each, and in part to the range of his experience and the degree in which he has profited by it.' This seems to correspond exactly with what we call a 'straight eye,' that faculty by which a man sees at a glance whether a line is straight, and whether a square or circle is true. A good carpenter can almost dispense with the square and foot-rule; his eye tells him if a thing is out of line. But there are men almost destitute of this perception, who cannot hang a picture straight, or lay a table-cloth evenly. So there are men, and women oftener, who always act sensibly in the common affairs of life, because they see the whole situation instinctively. They do not reason about it; in fact, such persons are generally the least able to give a reason for the course they take; they see it to be right, and that is enough. But

there are others who never can see the true bearings of things and always blunder.

The supreme perception

It would be a very interesting exercise, and one fraught with much profit of practical wisdom, to go once more over all that we have noted of the operation of the eye and the other senses, and of the way in which the use of them is acquired and improved, and to see what a light they throw upon the subject of 'common sense,' and still more on what we call 'good taste.' But we must pass on. For there is one supreme exercise of the inward eye, as of the outward, when it does not seem to bring knowledge to the head so much as satisfaction to the heart; and with a few thoughts on this we must close. But this is an awful theme. Like a sublime, snow-capped mountain, it bounds the varied prospect on which we have been gazing. Its base is on the earth, but its peaks reach to heaven. As we approach this subject, then, let us try to enter into the spirit of the poet standing at the foot of Mont Blanc:

> Thou, most awful Form,
> Risest from forth thy silent sea of pines
> How silently! Around thee and above
> Deep is the air and dark, substantial, black,
> An ebon mass! Methinks thou piercest it
> As with a wedge! But when I look again,
> It is thine own calm home, thy crystal shrine,

Thy habitation from eternity.
O dread and silent Mount! I gazed upon thee,
Till thou, still present to the bodily sense,
Didst vanish from my thought; entranced in prayer
I worshipped the Invisible alone.

CHAPTER XV

THE MORAL SENSE

'The statutes of the Lord are right, rejoicing the heart'

The perception of good and evil

How did he know that they were right? Had he arrived at that conviction by accumulated experiences of utility, or by conclusions deduced from the 'greatest good of the greatest number'? No, we may safely say that the clear heaven of David's soul had never been beclouded by any ratiocinations of that sort. He knew that the statutes of the Lord were right, as he knew when his harp was in tune, by the rejoicing of his heart. Speculate by all means on the philosophy of ethics, if that is the bent of your mind, and study the laws of acoustics and the principles of art; but remember that, before man knew anything about acoustics, he tuned his 'chorded shell' by his ear, and when the theory of music has done all it can for him, it is to his ear that the last appeal must lie in every

question of harmony or discord. And so it is not by creeds and catechisms, not by books and teachers, but by the moral sense that the knowledge of good and evil enters the soul of a man. The function of moral philosophy is to follow reverently and find the reasons for the judgments of that sense if they can. Oh! let us be clear on this point; for the present age is drunk with too much information. No previous age in this world's history was ever so filled with intoxicating knowledge about all manner of things as we are. But to know all that can be known *about* a thing falls very far short of knowing the thing itself, and this knowledge science is powerless to impart. A man may have studied the theory of music in every school in Europe and may be able to sit in criticism on the compositions of Handel and Mozart; but if he be deaf he will never know to his dying day what music is. And this is not less, but more, true of the moral sense. If there be such a creature in this world as a man who is devoid of that, then it is beyond the power of philosopher or theologian to make that man know what *Goodness* is. There may be such a man. Strange monstrosities are born at times into this world, and I would not deny the possibility of a man, otherwise sane, but blind of heart from his birth. If there be such, it is a righteous thing to

hope that the gallows will rid us of him soon. But as to what some travellers tell us of races of savages who have no notion of the difference between right and wrong, I do not believe it. I would not believe it on the authority of any traveller. Happily we have the evidence of the most trustworthy travellers to the contrary. 'On questioning intelligent men among the Bakwains,' says Livingstone, 'as to their former knowledge of good and evil, of God and the future state, they have scouted the idea of any of them ever having been without a tolerably clear conception on all these subjects. Respecting their sense of right and wrong, they profess that nothing we indicate as sin ever appeared to them as otherwise, except the statement that it was wrong to have more wives than one.' But Livingstone has left us better testimony than his words. The extraordinary ascendency which he acquired and the affection with which he was regarded wherever he became known are proof enough that the darkest hearts in Africa can see the beauty of an upright, brave, true and loving character. This perception, too, thank God! is innate in every normally constituted child of Adam.

This faculty also is innate

But you will ask—and you may well ask—'If this is the case, then how can men believe that right

is wrong and wrong is right? How can men endure to live, as whole races of savages have done for generations, in the daily practice of hatred, cruelty and deceit, and take a positive delight in treachery and murder?'

And may be improved or deteriorated

This is a dark problem; but let us hold it in the light of those more physical perceptions which are but the lower rungs of the ladder. We have seen that, though every complete man is born with ears and eyes, he is not born with the knowledge of the use of them, but must learn that for himself in the school of life. And when he has learned the use of them he begins to find that, apart altogether from their practical utility, they open up to him avenues of mysterious delight. In the measured motion of rhythmic time, in the glow of a bright colour, in the proportions of a symmetrical figure, he experiences a simple pleasure which allures him to seek such things. But 'the eye is not satisfied with seeing, nor the ear filled with hearing.' The more he yields to this allurement the stronger grows its hold upon him. And his perceptions grow keener and his taste more fastidious, so that what pleased him yesterday is not good enough to-day. More than this, what was indifferent yesterday becomes positively displeasing to-day, by reason of the increasing contrast which it presents to that in which he has learned to

delight. So he rises into a being with higher pleasures and higher pains than he was at the first. But we are not always surrounded with things that are beautiful and melodious. True, we might always find such things if we would seek them, but there is a vein of indolence in us all which makes that quest irksome; and so, as Goethe says, 'men are inclined to content themselves with what is commonest, and the spirit and the senses grow dead to the impressions of the beautiful and the perfect.' This is the *facilis descensus Averni*, and there is no bottom to the pit into which it leads. Go into the dark places of any great city and see how a life of poverty and squalor may habituate a man to the offence of every one of the five senses, until he ceases to know that it is any offence. But will anyone affirm that the most unwashed and repulsive child in those gutters is *incapable* of growing up to delight in cleanliness and all sweetness and beauty and harmony?

All this is terribly true of the moral sense. That divine boon, the power to discern and delight in goodness and truth, has been imparted to each one of us at our entry into this world; but what it will be to us depends on ourselves. That it can ever be entirely obliterated I do not believe; but it may be dulled, debased, perverted, until it almost ceases to be recognisable. On the other hand, it

may be exercised and trained and refined until it becomes as sensitive to the moral aspect of every line of conduct in the most perplexing affairs of life as the ear of the leader of an orchestra is to each note of all the instruments that sound simultaneously around him. So the writer of the Epistle to the Hebrews speaks of mature Christians as those who, 'by reason of use, have their senses exercised to discern good and evil.' And the apostle Paul prays for the young converts at Philippi, 'that your love may abound yet more and more in knowledge and all discernment' (or 'perception,' as Dean Alford translates it) 'so that ye may approve the things that are excellent.' They had love, they were true Christians; but they had very lately emerged from heathenism, and their moral perceptions were no doubt very confused. And see how, a little further on in the same Epistle, he points the path of progress: 'Finally, brethren, whatsoever things are true, whatsoever things are honourable, whatsoever things are pure, whatsoever things are of good report, if there be any virtue and if there be any praise, think on these things.' Is this not the very same course which Goethe prescribes for 'nourishing in our minds the faculty of feeling' the beautiful and perfect? 'For this reason we ought, every day at least, to hear a little song, read a good

The path of upward progress

poem, see a fine picture.' For there is no other way of cultivating our perceptions of excellence in any department than by the constant and loving contemplation of that which is excellent.

> And so the Word had breath and wrought
> With human hands the creed of creeds,
> In loveliness of perfect deeds,
> More strong than all poetic thought.
>
> Which he may read who binds the sheaf,
> Or builds the house, or digs the grave,
> And those wild eyes that watch the wave
> In roarings on the coral reef.

Action must answer to perception

There is yet another parallel which we must on no account miss. When writing of music I remarked that a man with an ear cannot walk within hearing of a band without keeping step with it. If he persisted in doing so, he would not only distress his ear, but inevitably deteriorate it. The universal practice of dancing, among all nations, is another illustration of the same thing. I am persuaded that we have to do here with a profound law of our own nature, which makes the full enjoyment of any well-pleasing perception dependent upon our bringing ourselves into unison with it. Any felt discordance between the motions within us and that gladdening influence from without jars, and will ultimately impair, the delicate mechanism of the instrument

by which it is apprehended. And does this law not extend to other perceptions, to the sense of beauty, for example? Surely it does. We may see a simple illustration of it in the impulse which prompts the savage, when he has found a pretty thing, to deck his own person with it. Not that this impulse is confined to savages.

> But who can view the ripened rose nor seek
> To wear it?

And it is almost a truism to say that, if a man has any taste, it will show itself in his dress and in his dwelling. No doubt, through indolence and slovenly habits, a man may allow his surroundings to fall far below what he is capable of approving; but everyone who does so pays the penalty in the gradual deterioration of his perceptions.

How many times more true is all this in the case of the moral sense? When the heart is still young and tender, how spontaneously and sweetly and urgently does every vision of goodness and nobleness in the conduct of another awaken the impulse to go and do likewise! And if that impulse is not obeyed, how certainly does the first approving perception of the beauty of goodness become duller and duller, until at last we may even come to hate it where we find it for its discordance with 'the motions of sins in our members.' But not less

certainly will every earnest effort to bring the life into unison with what we perceive to be right bring its own reward in a clearer and more joyful perception of what is right, and a keener sensitiveness to every discord in ourselves. How all such discord may be removed, how the chords of the heart may be tuned and the life become music —these are questions of religion, which is quite beyond our scope. But I take it that every religion which has prevailed among the children of Adam is in itself an evidence that, however debased and perverted the moral sense may have become, the painful consciousness that his heart is 'like sweet bells jangled' still presses everywhere and always on the spirit of man; and it is also a conscious or unconscious admission that there is no blessedness for him until his life shall march in step with the music of the Eternal Righteousness.

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